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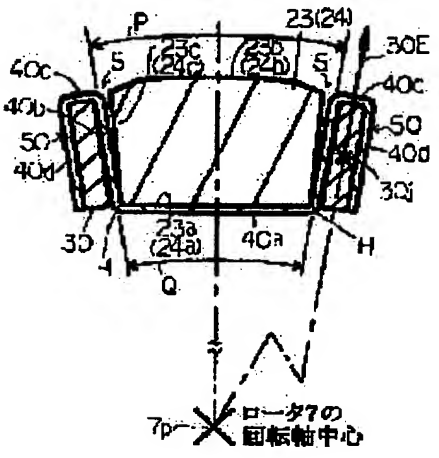
(54) ROTOR STRUCTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce centrifugal force applied during rotation of a rotor by providing a pole core having claw poles projecting to mesh each other, and a reinforcing body included such that the outer circumferential surface of a magnet for reducing flux leakage from the side face of adjacent claw pole enlarges mutually.
SOLUTION: A magnet 30 is provided on side faces 23c, 24c of a claw pole 23, 24, while inclining in a direction of enlarging from the center line thereof passing through the center of rotation 7p of a rotor 7 toward the outer circumferential surface 23b, 24b side and thereby no holding part is required. It is cantilevered by a reinforcing body 40 using adhesives. A centrifugal force 30E, being applied to the center of gravity 30j of the magnet 30 during rotation of the rotor 7, is absorbed by the reinforcing body 40 in the form of a moment for turning the magnet 30 and a part of the reinforcing body 40 for holding the magnet 30. Since a side face magnet body 50 turns such that the outside diameter side thereof approaches the side 23c, 24c of the claw pole, the stress becomes less than an allowable range.



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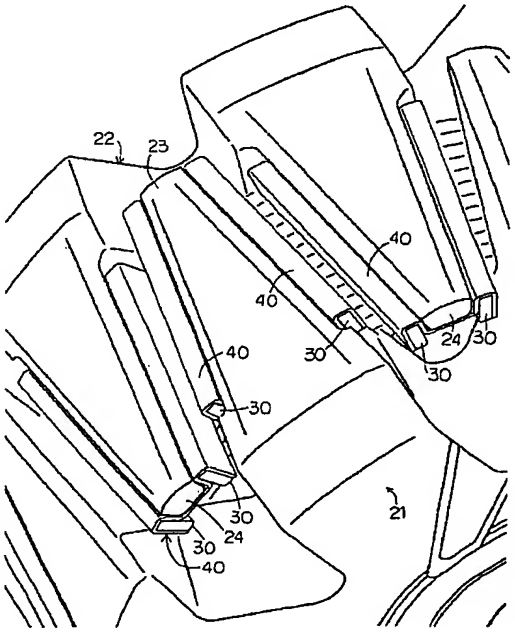
(54)【発明の名称】　ロータ構造

(57)【要約】
【課題】　爪状磁極同志の磁束漏洩を防止する磁石に加わる遠心力を低減する。
【解決手段】　爪状磁極２３，２４の両側面２３ｃ，２４ｃに配設され、爪状磁極２３，２４同志の磁束漏洩を低減する磁石３０と、この磁石３０を外周側が互いに広がるように傾斜する如く支持する補強体４０とを備えた。



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【特許請求の範囲】

【請求項１】　磁束を発生するロータコイルと、このロータコイルを覆って設けられ、交互に噛み合うように突出される爪状磁極をそれぞれ有する第１のボールコア体及び第２のボールコア体から構成されたボールコアと、上記爪状磁極の両側面側に配設され、隣り合う爪状磁極の側面同志の磁束の漏洩を低減する磁石と、この磁石を外周側が互いに広がるように傾斜する如く支持する補強体とを備えたことを特徴とするロータ構造。

【請求項２】　上記補強体は、爪状磁極の内周面に沿う内周部と、この内周部の両端から爪状磁極の側面へ折曲された折曲部と、この折曲部から折曲された磁石の外周面を押さえ付ける押さえ付け部と、押さえ付け部から磁石の外周面へ折返された折り返し部とより成り、補強体の内周側に上記磁石を支持したことを特徴とする請求項１に記載のロータ構造。

【請求項３】　上記補強体は、爪状磁極の内周面と磁石の内周面に沿う内周部と、この内周部の両端から磁石の側面へ折曲された折曲部と、この折曲部から爪状磁極に突出して爪状磁極の外周面を押さえ付ける押さえ付け部とより成り、補強体の外周側に上記磁石を支持したことを特徴とする請求項１に記載のロータ構造。

【請求項４】　上記磁石と補強体の磁石を支持した部分とにより側面磁石体を構成して、この側面磁石体と上記爪状磁極の側面との間に間隙を設け、上記磁石に遠心力が加わったときに、側面磁石体が爪状磁極側に上記間隙を狭めるように回動し、この回動力により補強体が変形して上記遠心力を補強体で吸収することを特徴とする請求項２又は請求項３に記載のロータ構造。

【請求項５】　上記側面磁石体の回動中心は、ロータの回転軸中心と磁石の重心とを結ぶ線よりも爪状磁極側に位置され、上記側面磁石体の回動は、爪状磁極の側面に当接することで係止されることを特徴とする請求項４に記載のロータ構造。

【請求項６】　上記押さえ付け部と折り返し部とで磁石を支持して磁石とともに側面磁石体を構成し、この側面磁石体と上記爪状磁極の側面との間に間隙を設け、かつ隣り合う側面磁石体の相互間に間隙を設け、上記磁石に遠心力が加わったときに、側面磁石体が隣り合う側面磁石体側に上記側面磁石体相互間の間隙を狭めるように回動し、この回動力により補強体が変形して上記遠心力を補強体で吸収し、上記側面磁石体の回動は、隣り合う保持部同志が当接して互いに係止し合うことを特徴とする請求項２に記載のロータ構造。

【請求項７】　上記側面磁石体と上記爪状磁極の側面との間の間隙は、上記側面磁石体の回動が係止されて補強体の変形量が最大になってから上記磁石に遠心力が加わらなくなったときに、変形した補強体が元の形状に戻るように、離間されたことを特徴とする請求項４又は請求項６に記載のロータ構造。

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【請求項８】　上記側面磁石体と上記爪状磁極の側面との間の間隙は、上記側面磁石体の回動が係止されて補強体の変形量が最大になったときに補強体に加わる応力が、少なくとも許容応力以下となるように、離間されたことを特徴とする請求項４又は請求項６に記載のロータ構造。

【請求項９】　上記側面磁石体と上記爪状磁極の側面との間の間隙には、弾性体を介在させたことを特徴とする請求項４又は請求項６に記載のロータ構造。

【請求項１０】　上記爪状磁極から補強体が内周側へ抜けることを防止する抜け止め構造を有することを特徴とする請求項１ないし請求項６のいずれかに記載のロータ構造。

【請求項１１】　上記爪状磁極から補強体が先端側へ抜けることを防止する抜け止め構造を有することを特徴とする請求項１ないし請求項６のいずれかに記載のロータ構造。

【請求項１２】　上記爪状磁極から補強体が内周側，先端側へ抜けることを防止する抜け止め構造を有することを特徴とする請求項１ないし請求項６のいずれかに記載のロータ構造。

【請求項１３】　上記抜け止め構造は、上記補強体より突出して爪状磁極の外周面に当接する当接部であることを特徴とする請求項１０ないし請求項１２のいずれかに記載のロータ構造。

【請求項１４】　上記抜け止め構造として、上記補強体を内周側から爪状磁極に押さえ付ける押さえ付け部材を用いたことを特徴とする請求項１０ないし請求項１２のいずれかに記載のロータ構造。

【請求項１５】　上記押さえ付け部材は、円筒状の外周面を有し、この外周面には補強体が組付けられた爪状磁極がはまる溝が形成され、爪状磁極の外周面と共にロータの外周面に円筒状の曲面を構成することを特徴とする請求項１４に記載のロータ構造。

【請求項１６】　上記爪状磁極の側面は、内周側よりも外周側に広がる向きに傾いた傾斜角度を有することを特徴とする請求項１ないし請求項１５のいずれかに記載のロータ構造。

【請求項１７】　上記磁石の重心は、爪状磁極の根元側に片寄って配置されることを特徴とする請求項１ないし請求項１６のいずれかに記載のロータ構造。

【請求項１８】　上記補強体は、金属製であることを特徴とする請求項１ないし請求項１６のいずれかに記載のロータ構造。

【請求項１９】　上記補強体は、爪状磁極に溶接で固定されることを特徴とする請求項１８に記載のロータ構造。

【請求項２０】　上記補強体は、磁石が補強体の先端側，根元側へ抜けることを防止する抜け止め構造を有することを特徴とする請求項１ないし請求項１６のいずれ

かに記載のロータ構造。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、交流発電機あるいは電動機のロータ構造、特に爪状磁極同志の磁束漏洩を防止する磁石の取り付け構造に関するものである。

【０００２】

【従来の技術】図１７は従来の交流発電機あるいは電動機のロータ構造を示す側断面図、図１８はこのロータの構成を示す斜視図であり、図２０はこのロータを部品単位で分解した側面図である。図１７に示す如く、この発電機は、アルミニウム製のフロントブラケット１及びリヤブラケット２から構成されたケース３と、このケース３内に設けられ、一端部にプーリ４が固定されたシャフト６と、このシャフト６に固定されたランドル型のロータ７と、ロータ７の両端面に固定されたファン５と、ケース３内の内壁面に固定されたステータ８と、シャフト６の他端部に固定されロータ７に電流を供給するスリップリング９と、スリップリング９に摺動する一対のブラシ１０と、このブラシ１０を収納したブラシホルダ１１と、ステータ８に電気的に接続されステータ８で生じた交流を直流に整流する整流器１２と、ブラシホルダ１１に嵌着されたヒートシンク１９と、このヒートシンク１９に接着されステータ８で生じた交流電圧の大きさを調整するレギュレータ２０とを備えている。

【０００３】ロータ７は、電流を流して磁束を発生する円筒状のロータコイル１３と、このロータコイル１３を覆って設けられ、その磁束によって磁極が形成されるボールコア１４とを備えている。ステータ８は、ステータコア１５と、このステータコア１５に巻回され、ロータ７の回転に伴ってロータコイル１３からの磁束の変化で交流が生じるステータコイル１６とを備えている。ボールコア１４は、一対の交互に噛み合った第一のボールコア体２１及び第２のボールコア体２２から構成されている。ボールコア体２１及びボールコア体２２は通常鉄製であり、ロータコイル１３が巻装される円筒部２１ｅ，２２ｅと、この円筒部２１ｅ，２２ｅが突設された円盤状の基部２１ｋ，２２ｋより成る。基部２１ｋ，２２ｋの外縁には、ロータコイル１３の外周とステータ８の内周との間の位置に、相互に噛み合う爪状磁極２３，２４をそれぞれ複数有している。上記爪状磁極２３，２４は、基部２１ｋ，２２ｋ側の厚み及び幅が大きく、先端側にいくに従って厚み及び幅が細くなる形状である。爪状磁極２３，２４の内周面２３ａ，２４ａは、先端にいくにつれ厚みが薄くなり、外周面２３ｂ，２４ｂは、ステータ８の内周面に沿った弧状である。爪状磁極２３，２４は、ロータ７の周方向に対して台形状の２つの側面２３ｃ，２４ｃを有する。各爪状磁極２３，２４は、その先端を向かい合わせて交互に噛み合わせられるので、爪状磁極２３，２４の内周面２３ａ，２４ａの傾斜が周方向に互い違いで並ぶことになる。また、爪状磁極２３，２４の側面２３ｃ，２４ｃは、根元側から先端側にいくにつれて先端側が細くなるように爪状磁極２３，２４の中心側に傾いている。

【０００４】図１８に示す如く、隣り合う爪状磁極２３，２４の間には、その対向する側面２３ｃ，２４ｃ同志で磁束の漏洩を減少する向きに着磁された直方体形状の磁石３０Ａが固着されている。

【０００５】動作を以下に説明する。図外のバッテリからブラシ１０，スリップリング９を通じてロータコイル１３に電流が供給されて磁束が発生し、第１のボールコア体２１の爪状磁極２３にはＮ極が着磁され、第２のボールコア体２２の爪状磁極２４にはＳ極が着磁される。一方、エンジンの回転力によってプーリ４が回転され、シャフト６によってロータ７が回転するためステータコイル１６には起電力が生じる。この交流の起電力は、整流器１２を通って直流に整流されるとともに、レギュレータ２０によりその大きさが調整されて、図外のバッテリに充電される。

【０００６】上記磁石３０Ａは、爪状磁極２３，２４間に挿入される一体構成の直方体形状以外にも、一体構成のリング形状もしくは他の樹脂等でパッキングしたリング状のもの等、様々な形状、爪状磁極２３，２４に対する固定手段で設けられている。しかし、これらはつぎの問題が発生する場合がある。すなわち、製作時にどうしても磁石３０Ａに応力がかかったり、回転による遠心力が磁石３０Ａに加わってしまうので、耐久性に劣っていた。また、ボールコア体２１，２２は、一般的に鍛造によって製作されるので、特に複雑な形状である爪状磁極２３，２４の細部は、精度がそれほど高く出せない。また、爪状磁極２３，２４同士，固体間のばらつきが生じている。このようなばらつきのある爪状磁極２３，２４の内周面２３ａ，２４ａに沿って、形状を合せた磁石３０Ａや、モールド等で形状を合せた支持部材は作りにくい。磁石３０Ａは、成形しやすさを考慮して製作すると、もろいので、ロータ７の爪状磁極２３，２４の周辺に用いるには、工夫が必要であった。しかし、磁石３０Ａに対して、厚みを十分にとったり、強度を重視した構成にすると、コストが高くなり量産には不都合であった。このようなばらつきに合せて磁石３０Ａや支持部材を製作し、爪状磁極２３，２４と磁石３０Ａ及び保持部材とのずれやギャップの差を小さくしたとする。しかし、この差がわずかであっても、ロータ７の回転時に遠心力を磁石３０Ａが受けると大きな力の差となり、磁石３０Ａや支持部材が損傷することが有り得る。また、爪状磁極２３，２４の内周面２３ａ，２４ａに関係なく爪状磁極２３，２４の側面２３ｃ，２４ｃで磁石３０Ａを支持したりする場合も、２個のボールコア体２１，２２を噛み合わせる際のずれや、回転力によるずれで、磁石３０Ａに力が加わる場合もあった。

【０００７】一方、ロータ７の回転による遠心力や発電時のステータ８との磁気吸引力によって、各爪状磁極２３，２４は、その先端部がロータコイル１３及びステータ８方向に往復する如く、それぞれ扇動する。これにより、爪状磁極２３，２４間の磁石３０Ａに荷重が加わって、磁石３０Ａに歪みが生じ、磁石３０Ａが破損することがあり得る。その対策の一例として、特開平１１－１３６９１３に開示されたものがある。これは、図１９ないし図２０に示す如く、磁石３０Ｂを構成する。すなわち、爪状磁極２３，２４毎に、爪状磁極２３，２４の内周面２３ａ，２４ａ及び側面２３ｃ，２４ｃ側を覆う如く構成して、磁石３０Ｂを固着したものである。ここで、互いに隣り合う磁石３０Ｂ，３０Ｂ同志は、磁石間隙間２５を設けている。これよって、爪状磁極２３と磁石３０Ｂと、爪状磁極２４と磁石３０Ｂとがそれぞれ扇動するので、磁石３０Ｂに荷重が加わらずに、磁石３０Ｂの破損を防いでいる。

【０００８】

【発明が解決しようとする課題】しかし、特開平１１－１３６９１３号公報に開示されたものは、ロータ７の回転による遠心力の磁石３０Ｂに対する影響軽減には無関係である。つまり、爪状磁極２３，２４と磁石３０Ｂが一体になって扇動するが、爪状磁極２３，２４に比べて磁石３０Ｂはもろいので、遠心力に対する耐久力が小さい。また、磁石３０Ｂが完全に露出しているので、ケース３内に入り込んでしまった飛翔物によって損傷することが考えられる。さらに、磁石３０Ｂの爪状磁極２３，２４への固定は、磁石３０Ｂの凸凹で構成するので、回転に対して強度が不十分であった。また、磁石３０Ｂにかかる遠心力を吸収するように、爪状磁極２３，２４の外周側にテープ等の支持部材を巻回して支持していた。しかし、これは回転中の動きまでは考慮していなく、テープで適正な保持ができているとは限らなかった。つまり、ロータ７の回転により、支持部材の重みが磁石３０Ｂにかかったり、偏って支持したりしてしまい、高速回転時には磁石３０Ｂのみならず、支持部材までも破壊してしまうおそれがあった。また、爪状磁極２３，２４の側面２３ｃ，２４ｃが軸方向に対して傾いたり、径方向に対して傾いたりしていることで、取り付ける個々の磁石３０Ｂ等も斜めとなる。磁石３０Ｂを取り付ける際には、軸中心に向けて傾いたり外れたりすることもあり、仮止めが必要となったりし、作業に手間取っていた。組立て作業の手間としては、ロータコイル１３を囲んで２つのボールコア体２１，２２を噛み合わせる際にも、いずれかの爪状磁極２３，２４の磁石３０Ｂ等が抜け落ちる方向に向いてしまう。さらに、その後にシャフト６を取り付けて持ち運びする際にも、軸中心に向けて磁石３０Ｂが落下する可能性があった。このとき、磁石３０の爪状磁極２３，２４への仮止めとして相互間に接着剤を塗布した場合、一般的に接着する両面を近づける力を加えた方が、乾燥，固定までの両者の位置関係を確保するにも良いことは周知である。この点、上記の構成の爪状磁極２３，２４と磁石３０Ｂとでは、両者が離れる方向に力がかかりやすく、接着剤塗布工程にさらに保持工程が不可欠であり、作業が大変複雑になってコスト高となる恐れがあった。また、この際に不手際が発生していると、高温低温等の厳しい環境で長期に用いられる車両用交流発電機としてロータ構造を用いたときに、爪状磁極２３，２４と磁石３０Ｂとの接着部が劣化を起こすことがあり、結果として磁石３０が飛散する恐れもあった。

【０００９】本発明は上記問題点を解消するためになされたもので、爪状磁極同志の磁束漏洩を減少する磁石に、ロータの回転時に加わる遠心力を低減するとともに、上記磁石を爪状磁極に取り付けることを目的とする。

【００１０】

【課題を解決するための手段】この請求項１に係る発明は、磁束を発生するロータコイルと、このロータコイルを覆って設けられ、交互に噛み合うように突出される爪状磁極をそれぞれ有する第１のボールコア体及び第２のボールコア体から構成されたボールコアと、上記爪状磁極の両側面側に配設され、隣り合う爪状磁極の側面同志の磁束の漏洩を低減する磁石と、この磁石を外周側が互いに広がるように傾斜する如く支持する補強体とを備えたものである。

【００１１】この請求項２に係る発明は、上記補強体は、爪状磁極の内周面に沿う内周部と、この内周部の両端から爪状磁極の側面へ折曲された折曲部と、この折曲部から折曲された磁石の外周面を押さえ付ける押さえ付け部と、押さえ付け部から磁石の外周面へ折返された折り返し部とより成り、補強体の内周側に上記磁石を支持したものである。

【００１２】この請求項３に係る発明は、上記補強体は、爪状磁極の内周面と磁石の内周面に沿う内周部と、この内周部の両端から磁石の側面へ折曲された折曲部と、この折曲部から爪状磁極に突出して爪状磁極の外周面を押さえ付ける押さえ付け部とより成り、補強体の外周側に上記磁石を支持したものである。

【００１３】この請求項４に係る発明は、上記磁石と補強体の磁石を支持した部分とにより側面磁石体を構成して、この側面磁石体と上記爪状磁極の側面との間に間隙を設け、上記磁石に遠心力が加わったときに、側面磁石体が爪状磁極側に上記間隙を狭めるように回動し、この回動力により補強体が変形して上記遠心力を補強体で吸収するものである。

【００１４】この請求項５に係る発明は、上記側面磁石体の回動中心は、ロータの回転軸中心と磁石の重心とを結ぶ線よりも爪状磁極側に位置され、上記側面磁石体の回動は、爪状磁極の側面に当接することで係止されるものである。

【００１５】この請求項６に係る発明は、上記押さえ付け部と折り返し部とで磁石を支持して磁石とともに側面磁石体を構成し、この側面磁石体と上記爪状磁極の側面との間に間隙を設け、かつ隣り合う側面磁石体の相互間に間隙を設け、上記磁石に遠心力が加わったときに、側面磁石体が隣り合う側面磁石体側に上記側面磁石体相互間の間隙を狭めるように回動し、この回動力により補強体が変形して上記遠心力を補強体で吸収し、上記側面磁石体の回動は、隣り合う保持部同志が当接して互いに係止し合うものである。

【００１６】この請求項７に係る発明は、上記側面磁石体と上記爪状磁極の側面との間の間隙は、上記側面磁石体の回動が係止されて補強体の変形量が最大になってから上記磁石に遠心力が加わらなくなったときに、変形した補強体が元の形状に戻るように、離間されたものである。

【００１７】この請求項８に係る発明は、上記側面磁石体と上記爪状磁極の側面との間の間隙は、上記側面磁石体の回動が係止されて補強体の変形量が最大になったときに補強体に加わる応力が、少なくとも許容応力以下となるように、離間されたものである。

【００１８】この請求項９に係る発明は、上記側面磁石体と上記爪状磁極の側面との間の間隙には、弾性体を介在させたものである。

【００１９】この請求項１０に係る発明は、上記爪状磁極から補強体が内周側へ抜けることを防止する抜け止め構造を有するものである。

【００２０】この請求項１１に係る発明は、上記爪状磁極から補強体が先端側へ抜けることを防止する抜け止め構造を有するものである。

【００２１】この請求項１２に係る発明は、上記爪状磁極から補強体が内周側，先端側へ抜けることを防止する抜け止め構造を有するものである。

【００２２】この請求項１３に係る発明は、上記抜け止め構造は、上記補強体より突出して爪状磁極の外周面に当接する当接部であるものである。

【００２３】この請求項１４に係る発明は、上記抜け止め構造として、上記補強体を内周側から爪状磁極に押さえ付ける押さえ付け部材を用いたものである。

【００２４】この請求項１５に係る発明は、上記押さえ付け部材は、円筒状の外周面を有し、この外周面には補強体が組付けられた爪状磁極がはまる溝が形成され、爪状磁極の外周面と共にロータの外周面に円筒状の曲面を構成するものである。

【００２５】この請求項１６に係る発明は、上記爪状磁極の側面は、内周側よりも外周側に広がる向きに傾いた傾斜角度を有するものである。

【００２６】この請求項１７に係る発明は、上記磁石の重心は、爪状磁極の根元側に片寄って配置されるものである。

【００２７】この請求項１８に係る発明は、上記補強体は、金属製であるものである。

【００２８】この請求項１９に係る発明は、上記補強体は、爪状磁極に溶接で固定されるものである。

【００２９】この請求項２０に係る発明は、上記補強体は、磁石が補強体の先端側，根元側へ抜けることを防止する抜け止め構造を有するものである。

【００３０】

【発明の実施の形態】以下、本発明の実施の形態について図面に基づき説明する。

【００３１】実施の形態１．図１ないし図３は、本発明の実施の形態１に係わるロータ構造を車両用交流発電機のロータに用いた場合を示し、図１は車両用交流発電機のロータの構成を示す要部斜視図、図２は分解斜視図、図３は補強体の断面図であり、図１７ないし図２０と同じものは同一符号を用いている。図１に示す如く、爪状磁極２３，２４同志の漏洩磁束を低減するように着磁されたフェライト磁石３０が、各爪状磁極２３の両側面２３ｃ，２３ｃに２つづつ、各爪状磁極２４の両側面２４ｃ，２４ｃに２つづつ配置される。この磁石３０は、ロータ７の回転時に上記磁石３０に加わる遠心力を、自身の変形により吸収する補強体４０によって、外周側が互いに広がるように傾斜する如く、爪状磁極２３，２４に支持されている。補強体４０は、厚み０．５ｍｍ程度のステンレス鋼等の金属プレートより成り、１枚の金属板をプレス加工により折り曲げて形成するので、容易に製作できる。この補強体４０は、図２ないし図３に示す如く、ロータ７の軸方向に対する断面が略Ｍ字形状であり、爪状磁極２３，２４の内周面２３ａ，２４ａに沿う台形板状の内周部４０ａと、この内周部４０ａの両端から外径側に折曲し、爪状磁極２３，２４の両側面２３ｃ，２４ｃに沿う折曲部４０ｂと、折曲部４０ｂの先端から磁石３０の外周面に折曲し、この外周面を押さえ付ける押さえ付け部４０ｃと、押さえ付け部４０ｃから磁石３０の側面側に折返される折り返し部４０ｄとより成る。これらの折曲部４０ｂ，押さえ付け部４０ｃ，折り返し部４０ｄで磁石３０を外周側から取り囲むとともに、折曲部４０ｂと折り返し部４０ｄで磁石３０を外周側から挟み込んで補強体４０の内周側に保持している。

【００３２】図３に示す如く、上記内周部４０ａとその両端の折曲部４０ｂ，４０ｂは、内周側の長さＱと比べて外周側の長さＰが広くなるように、折曲部４０ｂ，４０ｂの先端側が広がっており、ほぼＵ字状に形成される。磁石３０を囲んだ補強体４０の折曲部４０ｂ，押さえ付け部４０ｃ，折り返し部４０ｄは、磁石３０の断面外形に沿う逆Ｕ字状である。すなわち、磁石３０は、爪状磁極２３，２４の側面２３ｃ，２４ｃに、ロータ７の回転軸中心７ｐを通る爪状磁極２３，２４の中心線から外周面２３ｂ，２４ｂ側に広がる向きに傾けて設けられている。磁石３０は、図２に示す如く、爪状磁極２３，

２４との保持部を設ける必要がなく、その側面３０ｃは爪状磁極２３，２４の側面２３ｃ，２４ｃに沿った台形である。幅はほぼ一定であり、厚みが爪状磁極２３，２４の形状に合せて、先端側３０ｓから根元側３０ｎへ太くなる截頭四角錐形である。また、磁石３０は直方体状であってもよい。このように磁石３０を補強体４０に保持して、爪状磁極２３，２４に固定するためには、接着剤等が用いられる。つまり、補強体４０の内周部４０ａと爪状磁極２３，２４の内周面２３ａ，２４ａとの境界部分、補強体４０の折曲部４０ｂ，押さえ付け部４０ｃ，折り返し部４０ｄと磁石３０との境界部分に、接着剤が塗布される。爪状磁極２３，２４に固定する際には、爪状磁極２３，２４の側面２３ｃ，２４ｃと補強体４０の折曲部４０ｂと間には、間隙として微小空間Ｓを有して互いに離れて組付けられる。

【００３３】この構成により、図３におけるロータ７の回転時に磁石３０の重心３０ｊに加わる遠心力３０Ｅは、磁石３０と補強体４０の磁石３０が保持された部分を回動させる力（モーメント）となって、補強体４０に吸収される。上記磁石３０及び補強体４０の磁石３０が保持された部分（折曲部４０ｂ，押さえ付け部４０ｃ，折り返し部４０ｄ）を、側面磁石体５０として呼ぶことにして、図３を用いて側面磁石体５０に加わるモーメントを説明する。すなわち、側面磁石体５０は、その支点Ｈが補強体４０の内周部４０ａの両端にあり、いわゆる片持ち支持される。つまり、支点Ｈはロータ７の回転軸中心７ｐと磁石３０の重心３０ｊとを結ぶ線より爪状磁極２３，２４側に位置している。これにより、磁石３０へ加わる遠心力３０Ｅが、上記モーメントとして補強体４０に加わることになる。側面磁石体５０に加わる上記モーメントの方向は、回動中心が支点Ｈとなり、補強体４０の中心方向，つまり爪状磁極２３，２４の中心方向となる。従って、上記モーメントにより側面磁石体５０は、その外径側が爪状磁極２３，２４の側面２３ｃ，２４ｃに近づくように回動して変位する。この変位により補強体４０に応力が加わるが、この応力が許容応力以下となるように、上記微小空間Ｓが離間されており、補強体４０は破損しない。この場合、微小空間Ｓは、補強体４０が変位した後に、磁石３０に遠心力３０Ｅが加わらなくなったときに、補強体４０が元の形状に戻る程度の間隙である。これにより、補強体４０は、爪状磁極２３，２４を挟持するので保持力が高まり、結果として磁石３０と爪状磁極２３，２４との一体化が促進される。また、ロータ７の回転時に爪状磁極２３，２４の先端側が、内周側及び外周側に振動したときに、補強体４０のスプリングバック等により、側面磁石体５０の先端が広がることが考えられる。しかし、上記モーメントによる側面磁石体５０の変位は、上記スプリングバックを相殺する方向であり、磁石３０及び補強体４０が爪状磁極２３，２４から脱落するなどの不具合が回避できる。

【００３４】また、爪状磁極２３，２４の内周面２３ａ，２４ａが補強体４０の内周部４０ａに接しているため、発電時に爪状磁極２３，２４に伝導された熱が補強体４０によって放熱される。しかし、本実施の形態１の主としての目的は、磁石３０に加わる遠心力３０Ｅを低減させることである。この補強体４０に保持された磁石３０は、ロータコイル１３に対向する内径面側が露出しており、発電時に発生した熱が放熱される。残る３面は、ほぼ補強体４０で囲まれており、耐遠心力性が高い。万が一に飛翔物が外径側からぶつかったとしても、補強体４０で覆われているので磁石３０が損傷するおそれもない。爪状磁極２３，２４への装着時には、磁石３０が補強体４０で覆われた状態で組付けられ、かつ磁石３０と爪状磁極２３，２４が接する面がないため、組立て作業時に磁石３０が欠損することがない。爪状磁極２３，２４は、側面２３ｃ，２４ｃに補強体４０がはめ込まれる切り欠きが形成されるが、先端部が細くなる形状は従来例と同じである。従って、爪状磁極２３，２４の側面２３ｃ，２４ｃ相互間で形成される空間は、外周視で略平行４辺形となる。この個々の爪状磁極２３，２４の側面２３ｃ，２４ｃに、磁石３０が固着された補強体４０を組付けて、補強体４０同志で形成される空間は、巾は狭くなるが同じく略平行４辺形となる。これによって、爪状磁極２３，２４の先端がロータ７の回転時に扇動しても、磁石３０に応力が加わらずに破壊もしなくなる。

【００３５】また、補強体４０は接着材等を介して爪状磁極２３，２４に固着したが、補強体４０は金属製であるので、爪状磁極２３，２４の内周面２３ａ，２４ａと補強体４０の内周部４０ａとを溶接で接合しても良い。また、爪状磁極２３，２４の両側面２３ｃ，２４ｃと補強体４０の折曲部４０ｂとの間隙には、微小空間Ｓが設けられているが、この微小空間Ｓにゴムや樹脂等の弾性体を封入して介在させるようにしてもよい。形状としては、微小空間Ｓに合う三角柱状、薄板状や棒状等の挿入し易い形状とする。これによれば、同様の効果が得られるとともに、さらにこの弾性体が衝撃力を吸収するとともに、異物混入を抑えることもできる。

【００３６】実施の形態２．上記実施の形態１は、補強体４０の断面形状が略Ｍ字状であった場合を説明したが、この実施の形態２は、図４ないし図５に示すように、断面形状が略Ｃ字状の補強体４１を用いている。図５に示す如く、補強体４１は、爪状磁極２３，２４の内周面２３ａ，２４ａに沿って磁石３１の内周面まで延長された台形板状の内周部４１ａと、内周部４１ａの両端から外径方向に折曲されて磁石３１の側面を保持する折曲部４１ｂと、折曲部４１ｂの先端から爪状磁極２３，２４方向に突出し、磁石３１を内周側に押さえ付ける押さえ付け部４１ｃとより成る。押さえ付け部４１ｃは、磁石３１の外周側全面を覆う必要がなく、半分強を占め

る程度で磁石３１の保持確保ができる程度に、爪状磁極２３，２４の途中まで突出している。押さえ付け部４１ｃと爪状磁極２３，２４との間にはギャップがあり、磁石３１の外周側の一部が露出されている。この補強体４１の折曲部４１ｂと爪状磁極２３，２４の側面２３ｃ，２４ｃとで磁石３１を内周側より挟み込んで、磁石３１を補強体４１の外周側に保持して爪状磁極２３，２４に支持している。押さえ付け部４１ｃは、磁石３１の根元部が太くなっていることから、内周部４１ａで磁石３１をくさびのように挟むことになり、爪状磁極２３，２４の先端から磁石３１が抜けることを防止するものである。

【００３７】上記磁石３１の３面は、ほぼ補強体４１で取り囲まれ、残る１面は爪状磁極２３，２４の側面２３ｃ，２４ｃに接するので、大きな露出面がなく、耐久性が高い。また、磁石３１は実施の形態１の磁石３０と比較すると、太幅のものを用いることができる。すなわち、爪状磁極２３，２４相互間に注目すると、補強体４１には補強体４０の折り返し部４０ｄに相当する部分を設ける必要がなく、周方向に対して補強体４１の板厚の占める割合が半分となる。そのため、磁石３０と比べて、その厚み分大きな磁石３１となり、さらに車両用交流発電機の出力が上昇することになる。実施の形態１と同様に、爪状磁極２３，２４の側面２３ｃ，２４ｃと磁石３１との間隙には、微小空間Ｓを有して離れており、その他の部分が接着材等で固定される。つまり、磁石３１と補強体４１の折曲部４１ｂ，押さえ付け部４１ｃとの境界部分に接着剤が塗布されて、これらが側面磁石体５１を構成する。磁石３１の重心３１ｊに加わる遠心力３１Ｅのモーメントを考えると、実施の形態１と同様である。すなわち、側面磁石体５１は、爪状磁極２３，２４の内周面２３ａ，２４ａと側面２３ｃ，２４ｃの角部に当たる内周部４１ａの支点Ｈが回動中心となり、爪状磁極２３，２４の中心方向に変位する。実施の形態１とは異なる点は、磁石３１が補強体４１の外周側に配置されるので、補強体４１の内周部４１ａは、磁石３１の内周面を覆う分長さが内周部４０ａより長くなり、補強体４１のスプリングバックを相殺する力が増強される。これにより、磁石３１の脱落防止を促進するとともに、さらに爪状磁極２３，２４と磁石３１とが一体化される。また、図６に示す如く、補強体４１の内周部４１ａの上，下両端を折曲して抜け止め部４１ｎ，４１ｎを設けてもよい。これにより、磁石３１が補強体４１の先端側，根元側から抜け落ちることを確実に防止できる。抜け止め部４１ｎは、折曲部４１ｂの上，下両端に設けてもよい。

【００３８】実施の形態３．上記実施の形態１は、爪状磁極２３，２４の側面２３ｃ，２４ｃと補強体４０の折曲部４０ｂとの間に微小空間Ｓを設けた場合を説明したが、この実施の形態３は、図７（ａ），（ｂ）に示すように、磁石３０は、押さえ付け部４０ｃと折り返し部４０ｄとに接着されている。この押さえ付け部４０ｃ，折り返し部４０ｄ，磁石３０で側面磁石体５０を構成する。そして、隣り合う側面磁石体５０相互の間隙に微小空間Ｕを設け、さらに、補強体４０の折曲部４０ｂと磁石３０の側面との間隙に、微小空間Ｔを設けるものである。この場合は、側面磁石体５０の回動中心が異なり、折曲部４０ｂの外周先端が支点Ｊとなり、片持ち支持となる。磁石３０の重心に加わる遠心力のモーメントによる側面磁石体５０の変位は、実施の形態１とは逆方向となる。すなわち、隣り合う補強体４０の折り返し部４０ｄ同志が近づく方向、つまり爪状磁極２３，２４の周方向中心側に向いて、微小空間Ｕを狭めるように側面磁石体５０が隣り合う側面磁石体５０側に回動する。この場合の上記微小空間Ｓは、設けなくともよいが、微小空間Ｓを設ける場合には接着材で固着してもよく、樹脂等の弾性体を充填して介在させるようにしてもよく、微小空間Ｔより小さければよい。これにより、図７（ｂ）に示すように、ロータ７の回転時に側面磁石体５０の内周側は、周方向に微小空間Ｕを狭める方向に変位するので、同様にして隣りの側面磁石体５０が微小空間Ｕを狭める方向に変位する。すると、補強体４０の折り返し部４０ｄ同志が当接して、側面磁石体５０同志が互いに支持し合うことになる。こうすることで、不要な変位が抑えられるので、高速回転時の耐遠心力性も向上できる。また、補強体４０同士が当接するので、磁石３０には影響を与えない。また、回動中心となる支点Ｊから爪状磁極２３，２４側の補強体４０の折曲部４０ｂには影響を与えない。

【００３９】実施の形態４．上記実施の形態２は、補強体４１の押さえ付け部４１ｃは磁石３１の外周面の途中まで突出した場合を説明したが、この実施の形態４は、図８ないし図９に示すように、押さえ付け部４１ｃの上，下端から爪状磁極２３，２４の外周面２３ｂ，２４ｂの一部まで突出する細幅の当接部４１ｔ，４１ｔを構成したものである。なお、図９（ａ），（ｂ）は、それぞれ図８におけるＢ－Ｂ線，Ａ－Ａ線断面視に相当する断面図である。当接部４１ｔは、爪状磁極２３，２４の外周面２３ｂ，２４ｂの周方向両端に形成される面取り部２３ｍ，２４ｍの途中まで突出して係止されるので、爪状磁極２３，２４から補強体４１が内周方向へ抜けることを防止する。これは、爪状磁極２３，２４に対しては、追加の加工は不要である。しかし、設計上の理由により加工を施した場合でも、当接部４１ｔの板厚分のわずかな加工で良く、磁気回路への影響は無視できる。また、当接部４１ｔは補強体４１の押さえ付け部４１ｃの軸方向両端から一部が突出しているので、磁石３１の露出面積は確保されており、冷却性を低下させない。この構成によれば、爪状磁極２３，２４に接着材を介して補強体４１及び磁石３１を取り付ける際には、治具によっ

て個々を保持する必要がなくなり、大幅なコストダウンが可能となる。そればかりでなく、経年によって接着剤が劣化すること等を考慮しても、補強体４１の当接部４１ｔと内周部４１ａが爪状磁極２３，２４を挟持し続けるため、保持力を失わないので、高信頼性，高品質の製品が得られる。また、補強体４０に当接部を設ける場合には、押さえ付け部４０ｃの上，下端の一部を爪状磁極２３，２４の外周面２３ｂ，２４ｃ側に折返すことで形成できる。また、当接部は、押さえ付け部４０ｃ，４１ｃに板状の当接片を固着して設けてもよい。

【００４０】実施の形態５．上記実施の形態４は、爪状磁極２３，２４の面取り部２３ｍ，２４ｍには加工を施さなかったが、この実施の形態５では、図１０ないし図１１に示す如く、面取り部２３ｍ，２４ｍの当接部４１ｔ，４１ｔに対応する部分に、わずかにへこませた凹状の段部２３ｈ，２４ｈを設けたものである。この段部２３ｈ，２４ｈは、当接部４１ｔの軸方向の移動を規制するものであり、補強体４１が爪状磁極２３，２４の先端から抜けることを防止する。なお、図１１（ａ），（ｂ）は、それぞれ図１０におけるＣ－Ｃ線，Ａ－Ａ線断面視に相当する断面図である。この段部２３ｈ，２４ｈは、爪状磁極２３，２４に対して補強体４１を装着した際に、爪状磁極２３，２４の外周面２３ｂ，２４ｂと当接部４１ｔとがほぼ平らになるように形成されている。この段部２３ｈ，２４ｈに当接部４１ｔがはまりこむことで、補強体４１つまりは磁石３１が爪状磁極２３，２４とが一体化されて形成される。そのため、組付けた後の全体の外周面としては、なだらかな曲面になって空気抵抗が減少し、回転抵抗を悪化させない。この段部２３ｈ，２４ｈは、爪状磁極２３，２４の面取り部２３ｍ，２４ｍの一部の形状を若干変更するだけで対応可能であり、別部材を追加する必要がない。この段部２３ｈ，２４ｈは、ボールコア体２１，２２を形成する型で構成するようにしてもよく、面取り部２３ｍ，２４ｍに加工して設けてもよい。また、わずかにへこませるだけなので、爪状磁極２３，２４に対して磁気的に影響を及ぼすことはない。結果としては、爪状磁極２３，２４への固定のための接着材が不要となり、さらに安価となり、かつ製作も容易となる。

【００４１】実施の形態６．上記実施の形態２は、補強体４１は接着剤のみで爪状磁極２３，２４に固定されていたが、この実施の形態６は、図１２に示す如く、補強体４１を内周側から爪状磁極２３，２４に押さえ付けるリング状の押さえ付け部材６０を用いるものである。これは、補強体４１が爪状磁極２３，２４の内周側または先端側から抜けることを防止する。実施の形態４，５と比べると、さらに補強体４１の爪状磁極２３，２４への保持度が高まることになる。図１２（ａ）に示す如く、それぞれの爪状磁極２３，２４の所定位置に、磁石３１を保持した補強体４１を配置した後に、図１２（ｂ），（ｃ）に示す如く、補強体４１の内周部４１ａの中央部付近に当接する直径を有する押さえ付け部材６０をはめこんで構成する。この押さえ付け部材６０は、補強体４１の内周部４１ａの軸方向傾斜に合った傾きを外周面に有したものであり、接着面積が大きく密着度が高い。これにより、爪状磁極２３，２４に補強体４１を取り付けた状態で確実に保持でき、その後の持ち運びにも優れる。また、複数の補強体４１を爪状磁極２３，２４に対して一度に固定でき、補強体４１の構成も単純なもので可能となる。押さえ付け部材６０は、金属又はプラスチック等より成り、断面は長方形であってもよい。また、爪状磁極２３，２４と補強体４１の両者間に接着材を設けてあれば、接着面を近づける方向となり、余分な保持は不要となり、かつ接着強度が確保される。また、複数の補強体４１および磁石３１を押さえ付け部材６０とそろえて、組立て時の治具により保持して、これを爪状磁極２３，２４と一体化させるのであれば、接着材の固定はしなくても良い。また、上記押さえ付け部材６０は、補強体４０も使用でき、内周部４０ａが押さえつけられる。

【００４２】実施の形態７．実施の形態６は、押さえ付け部材６０の外周は補強体４０，４１の内周部４０ａ，４１ａに当接したが、この実施の形態７は、図１３ないし図１４に示す如く、リング状の押さえ付け部材７０は、ロータ７の外周と同一の円筒状の外周面７０ｂを有し、この外周面７０ｂには補強体４０が組付けられた爪状磁極２３，２４がはまる凹状の溝７０ｍが形成されるものである。図１４に示す如く、ロータ７として組付けたときに、爪状磁極２３，２４の外周面２３ｂ，２４ｂと共にロータ７の外周面がほぼ完全な円筒状の曲面を構成する。図１３に示す如く、押さえ付け部材７０の内周側は、ロータコイル１３との間に隙間があり、冷却風７０Ｆが通過してロータ７が冷却される。これにより、補強体４０が軸方向に幅広の押さえ付け部材７０で内周側から外周側に押さえられるので、実施の形態６と比べて、さらに確実に爪状磁極２３，２４と一体化できる。さらに、外周面７０ｂに円筒状曲面を有することで、複数の磁石３０を有するロータ７であっても回転による風音を悪化させない効果も有する。なお、押さえ付け部材７０の幅は、爪状磁極２３，２４の先端を覆う程度であったが、ボールコア体２１，２２の基部２１ｋ，２２ｋの端面まで突出する程度の幅を有してもよい。

【００４３】実施の形態８．この実施の形態８は、図１５（ａ），（ｂ）に示すように、爪状磁極２３，２４の側面２３ｃ，２４ｃの傾斜角度を、爪状磁極２３，２４の内周面２３ａ，２４ａより外周面２３ｂ，２４ｂ側がさらに広がるように形成したものである。この傾斜角度がきつくなった側面２３ｃ，２４ｃに沿って、補強体４０，４１が形成されている。これによれば、磁石３０，３１の内周側の先端は、外周視で見えにくくなり、あた

かも爪状磁極２３，２４の内周面２３ａ，２４ａ側にもぐりこむように配置されることになる。このようにすれば、磁石３０，３１単体に加わる遠心力３０Ｅ，３１Ｅは、２つの力に分散される。すなわち、側面２３ｃ，２４ｃに対して垂直方向に加わる抗力３０Ｋ，３１Ｋが増加し、側面２３ｃ，２４ｃに対して水平外周方向に加わる分散力３０Ｂ，３１Ｂが減少する。そのため、側面磁石体５０，５１の耐遠心力性が向上する。

【００４４】実施の形態９．この実施の形態９は、図１６に示すように、周方向断面視で磁石３０，３１は、根元側３０ｎ，３１ｎが先端側３０ｓ，３１ｓより太くなる形状で設けられる。図は補強体４０，４１等が省略され、爪状磁極２３，２４の周方向断面視で磁石３０，３１の形状を示している。すなわち、磁石３０，３１の重心は、爪状磁極２３，２４の先端側より根元側、つまりボールコア体２１，２２の基部２１ｋ，２２ｋ側に片寄ることになる。このようにすれば、爪状磁極２３，２４に磁気吸引力を受けたり、ロータ７の回転による遠心力によって爪状磁極２３，２４の先端が扇動するが、この変位が低減できる。つまり、磁石３０，３１へ影響する力も低減できる。

【００４５】

【発明の効果】以上説明したように、請求項１に記載の発明によれば、磁束を発生するロータコイルと、このロータコイルを覆って設けられ、交互に噛み合うように突出される爪状磁極をそれぞれ有する第１のボールコア体及び第２のボールコア体から構成されたボールコアと、上記爪状磁極の両側面側に配設され、隣り合う爪状磁極の側面同志の磁束の漏洩を低減する磁石と、この磁石を外周側が互いに広がるように傾斜する如く支持する補強体とを備えたので、磁石を補強体で囲んだ状態で個々の爪状磁極に確実に固定でき、磁石に工夫をしなくても、磁石及び補強体の磁石が保持された部分より成る側面磁石体の強度を高くでき、耐遠心力性も高い。

【００４６】また、請求項２に記載の発明によれば、上記補強体は、爪状磁極の内周面に沿う内周部と、この内周部の両端から爪状磁極の側面へ折曲された折曲部と、この折曲部から折曲された磁石の外周面を押さえ付ける押さえ付け部と、押さえ付け部から磁石の外周面へ折返された折り返し部とより成り、補強体の内周側に上記磁石を支持したので、製作が容易で安価なものができ、補強体自体の強度も高く、また爪状磁極の内周面と側面とに補強体が連続して設けられるので、遠心力や爪状磁極にかかる扇動力を内周側から全面で受けることができ、磁石に影響する力を軽減できる。

【００４７】また、請求項３に記載の発明によれば、上記補強体は、爪状磁極の内周面と磁石の内周面に沿う内周部と、この内周部の両端から磁石の側面へ折曲された折曲部と、この折曲部から爪状磁極に突出して爪状磁極の外周面を押さえ付ける押さえ付け部とより成り、補強体の外周側に上記磁石を支持したので、製作が容易で安価なものが得られるとともに、爪状磁極の内周面と磁石の内周面とに補強体が連続して設けられるので、遠心力や爪状磁極にかかる扇動力を内周側から全面で受けることができ、磁石に影響する力を軽減できる。

【００４８】また、請求項４に記載の発明によれば、上記磁石と補強体の磁石を支持した部分とにより側面磁石体を構成して、この側面磁石体と上記爪状磁極の側面との間に間隙を設け、上記磁石に遠心力が加わったときに、側面磁石体が爪状磁極側に上記間隙を狭めるように回動し、この回動力により補強体が変形して上記遠心力を補強体で吸収するので、ロータの回転により遠心力が発生しても、上記側面磁石体が爪状磁極を挟持するように、個々の爪状磁極の中心方向側に向かって回動して変位するために、補強体の保持力が強化され、耐遠心力性も高い。

【００４９】また、請求項５に記載の発明によれば、上記側面磁石体の回動中心は、ロータの回転軸中心と磁石の重心とを結ぶ線よりも爪状磁極側に位置され、上記側面磁石体の回動は、爪状磁極の側面に当接することで係止されるので、遠心力が増加しても側面磁石体が確実に固定され、さらなる変位を抑制でき、磁石に遠心力が加わらずに耐遠心力性が高い。

【００５０】また、請求項６に記載の発明によれば、上記押さえ付け部と折り返し部とで磁石を支持して磁石とともに側面磁石体を構成し、この側面磁石体と上記爪状磁極の側面との間に間隙を設け、かつ隣り合う側面磁石体の相互間に間隙を設け、上記磁石に遠心力が加わったときに、側面磁石体が隣り合う側面磁石体側に上記側面磁石体相互間の間隙を狭めるように回動し、この回動力により補強体が変形して上記遠心力を補強体で吸収し、上記側面磁石体の回動は、隣り合う保持部同志が当接して互いに係止し合うので、遠心力が増加しても側面磁石体が確実に固定され、さらなる変位を抑制でき、磁石に遠心力が加わらずに耐遠心力性が高い。

【００５１】また、請求項７に記載の発明によれば、上記側面磁石体と上記爪状磁極の側面との間の間隙は、上記側面磁石体の回動が係止されて補強体の変形量が最大になってから上記磁石に遠心力が加わらなくなったときに、変形した補強体が元の形状に戻るように、離間されたので、再び遠心力が加わったときに、側面磁石体が回動でき、補強体が破損することなく回動動作を繰返すことができる。

【００５２】また、請求項８に記載の発明によれば、上記側面磁石体と上記爪状磁極の側面との間の間隙は、上記側面磁石体の回動が係止されて補強体の変形量が最大になったときに補強体に加わる応力が、少なくとも許容応力以下となるように、離間されたので、側面磁石体が回動して最大に変位しても、補強体の変形量は許容以下となり、過大な応力で補強体が破損することがない。

【００５３】また、請求項９に記載の発明によれば、上記側面磁石体と上記爪状磁極の側面との間の間隙には、弾性体を介在させたので、隙間を有しても異物がはさまったりせず、また、上記側面磁石体の変位時に爪状磁極との衝撃力も緩和できる。

【００５４】また、請求項１０に記載の発明によれば、上記爪状磁極から補強体が内周側へ抜けることを防止する抜け止め構造を有するので、補強体と爪状磁極との一体化が高まり、磁石が飛散せずに損傷を防止できるとともに、補強体を組付けたボールコア体を軸方向に対して水平にしても、補強体が内周側に抜けてしまうことがないため、持ち運びやセッティングの自由度も高く、作業性に優れる。

【００５５】また、請求項１１に記載の発明によれば、上記爪状磁極から補強体が先端側へ抜けることを防止する抜け止め構造を有するので、補強体と爪状磁極との一体化が高まり、磁石が飛散せずに損傷を防止でき、また、補強体が爪状磁極から軸方向に抜け落ちることがなく、補強体を取り付けたボールコア体同志を、ロータコイルを内包して容易に対に噛み合わせることができる。

【００５６】また、請求項１２に記載の発明によれば、上記爪状磁極から補強体が内周側，先端側へ抜けることを防止する抜け止め構造を有するので、簡単な構成で爪状磁極に対する補強体の内周方向，軸方向への移動を確実に規制でき、保持機能が高い。

【００５７】また、請求項１３に記載の発明によれば、上記抜け止め構造は、上記補強体より突出して爪状磁極の外周面に当接する当接部であるので、簡単な構成で爪状磁極の面取り部を挟持して、爪状磁極の内周方向へ対する補強体の抜け止め効果を有することができる。

【００５８】また、請求項１４に記載の発明によれば、上記抜け止め構造として、上記補強体を内周側から爪状磁極に押さえ付ける押さえ付け部材を用いたので、爪状磁極に対する補強体の内周方向，軸方向内周方向，軸方向への移動を規制するとともに、補強体に対して内周側から爪状磁極に向かって押し付ける力を付加できる。

【００５９】また、請求項１５に記載の発明によれば、上記押さえ付け部材は、円筒状の外周面を有し、この外周面には補強体が組付けられた爪状磁極がはまる溝が形成され、爪状磁極の外周面と共にロータの外周面に円筒状の曲面を構成するので、爪状磁極に対する補強体の内周方向，軸方向内周方向，軸方向への移動をさらに確実に規制でき、また、ロータの外周全体として滑らかな曲面となり、ロータの回転時に発生する風音が低減される。

【００６０】また、請求項１６に記載の発明によれば、上記爪状磁極の側面は、内周側よりも外周側に広がる向きに傾いた傾斜角度を有するので、爪状磁極の側面に垂直に加わる抗力が増加し、磁石単体に加わる遠心力が低減され、側面磁石体の耐遠心力性が向上する。

【００６１】また、請求項１７に記載の発明によれば、上記磁石の重心は、爪状磁極の根元側に片寄って配置されるので、ロータの回転時に爪状磁極の先端が扇動しても、この振幅量を低減できる。

【００６２】また、請求項１８に記載の発明によれば、上記補強体は、金属製であるので、工作自由度が高く、安価に製作できる。

【００６３】また、請求項１９に記載の発明によれば、上記補強体は、爪状磁極に溶接で固定されるので、補強体と爪状磁極とを確実に一体化できる。

【００６４】また、請求項２０に記載の発明によれば、上記補強体は、磁石が補強体の先端側，根元側へ抜けることを防止する抜け止め構造を有するので、補強体からの磁石の脱落を防止できる。

【図面の簡単な説明】

【図１】　本発明の実施の形態１に係わるロータ構造の構成を示す要部を示す斜視図である。

【図２】　実施の形態１に係わるロータ構造の要部を示す分解斜視図である。

【図３】　実施の形態１に係わる補強体，磁石を示す爪状磁極の軸方向視の断面図である。

【図４】　実施の形態２に係わるロータ構造の構成を示す要部を示す斜視図である。

【図５】　実施の形態２に係わる補強体，磁石を示す爪状磁極の軸方向視の断面図である。

【図６】　実施の形態２に係わる補強体の抜け止め部を示す斜視図である。

【図７】　実施の形態３に係わる補強体，磁石を示す爪状磁極の軸方向断面視の動作説明図である。

【図８】　実施の形態４に係わる当接部を示す側面視概略図である。

【図９】　実施の形態４に係わる当接部，補強体，磁石を示す爪状磁極の軸方向視の断面図である。

【図１０】　実施の形態５に係わる段部を示す側面視概略図である。

【図１１】　実施の形態５に係わる段部，当接部，補強体，磁石を示す爪状磁極の軸方向視の断面図である。

【図１２】　実施の形態６に係わる押さえ付け部材を補強体に装着した状態を説明する平面図である。

【図１３】　実施の形態７に係わる押さえ付け部材を示す軸方向視の断面図である。

【図１４】　実施の形態７に係わる押さえ付け部材、ロータを示す側面図である。

【図１５】　実施の形態８に係わる爪状磁極の側面，補強体，磁石を示す軸方向視の断面図である。

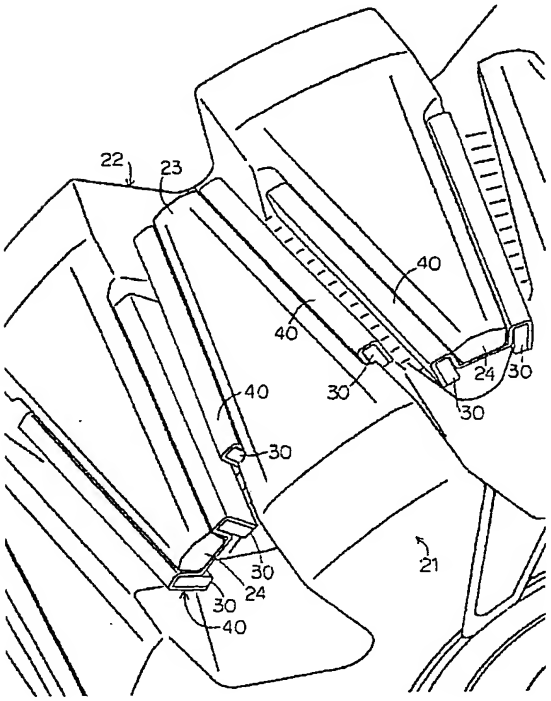
【図１６】　実施の形態９に係わる磁石の形状を示す爪状磁極の周方向視の断面図である。

【図１７】　従来のロータ構造を説明する車両用交流発電機の構成を示す断面図である。

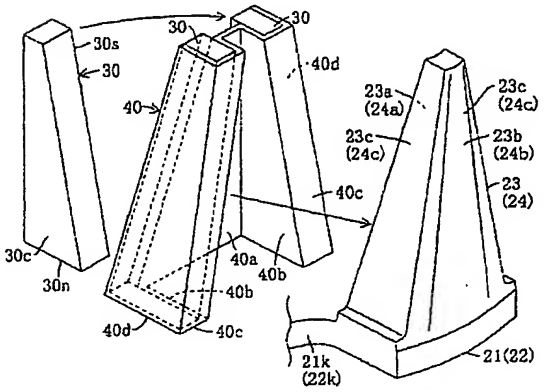
【図１８】　従来のロータ構造を説明する斜視図であ

る。
【図１９】　従来のロータ構造を説明する斜視図である。
【図２０】　従来のロータ構造を説明する分解側面図である。
【符号の説明】
＊２３，２４　爪状磁極、２３ａ，２４ａ　内周面、２３ｃ，２４ｃ　側面、３０，３１　磁石、４０，４１　補強体、４０ａ，４１ａ　内周部、４０ｂ，４１ｂ　折曲部、４０ｃ，４１ｃ　押さえ付け部、４０ｄ　折り返し部、５０，５１　側面磁石体。

【図１】



【図２】



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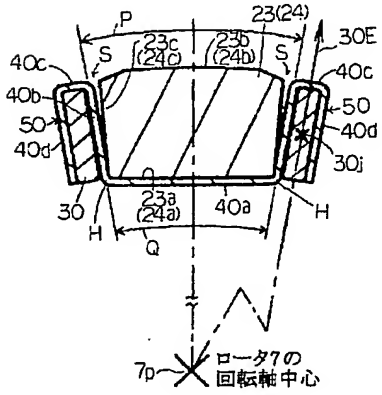

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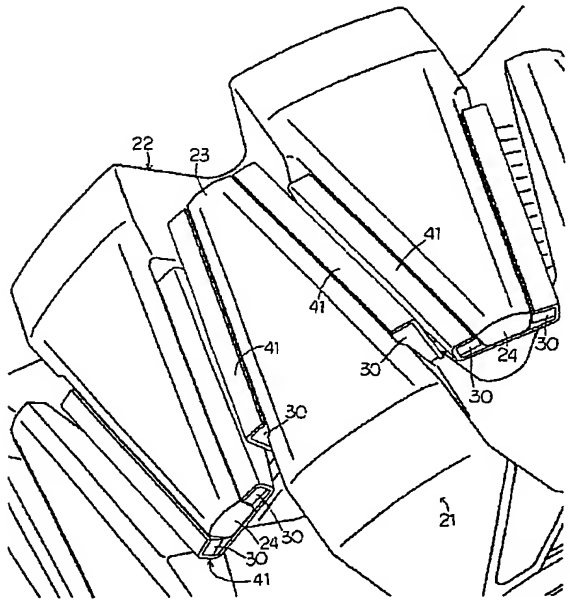

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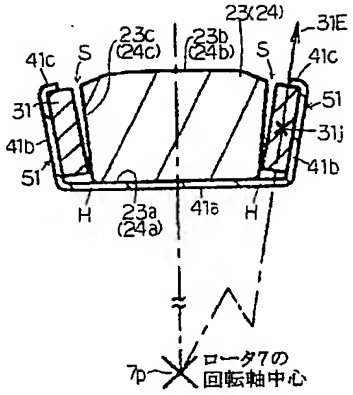
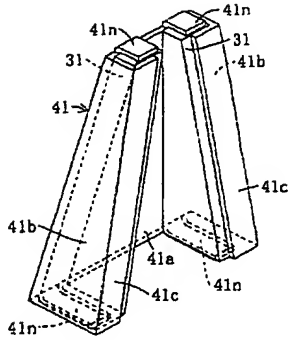
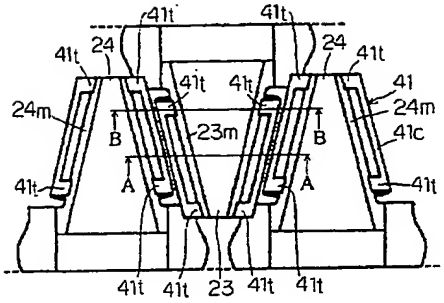


【図６】



【図８】



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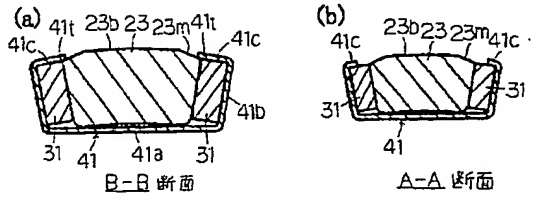

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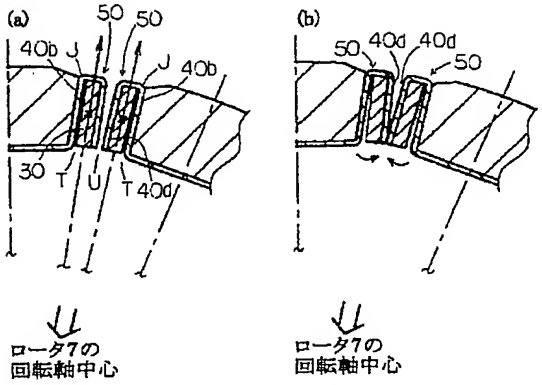
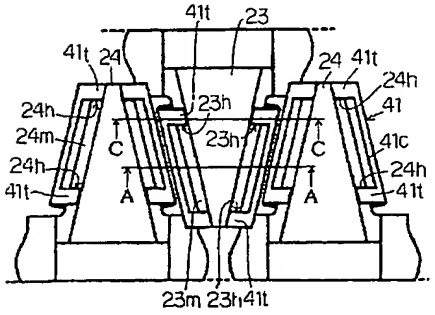


【図１０】



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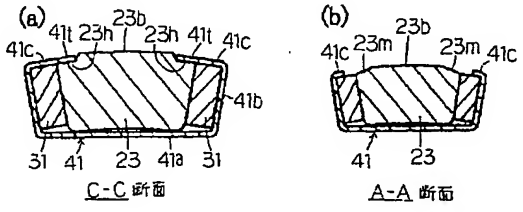

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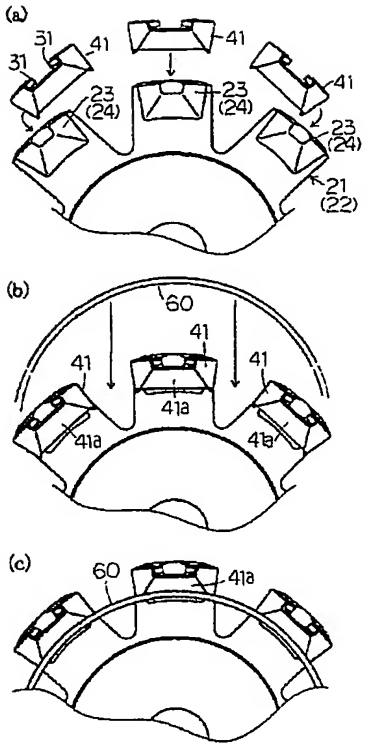

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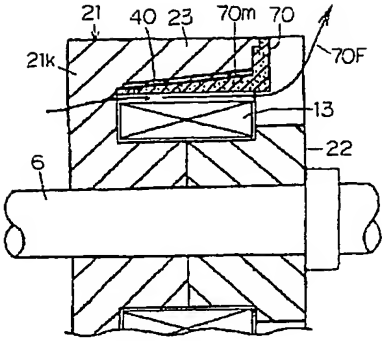

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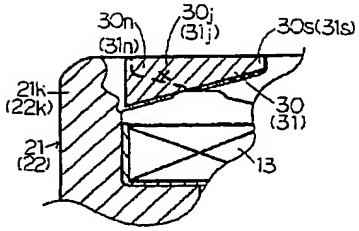

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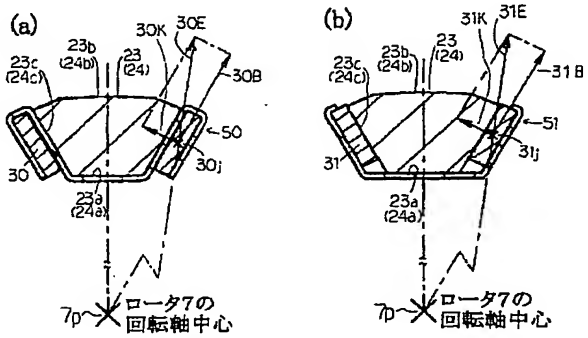
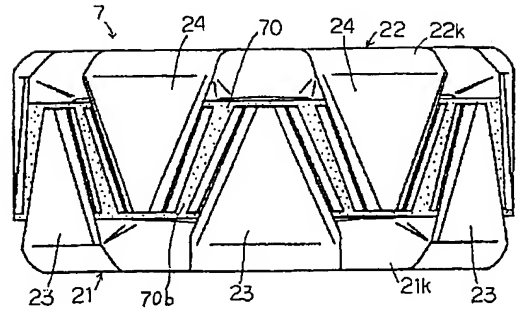
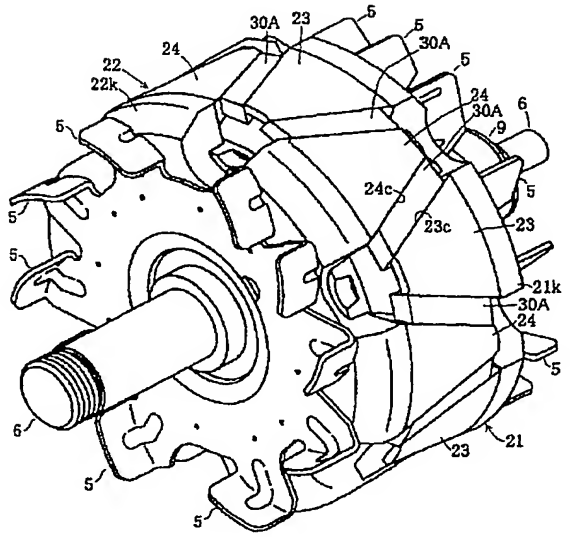


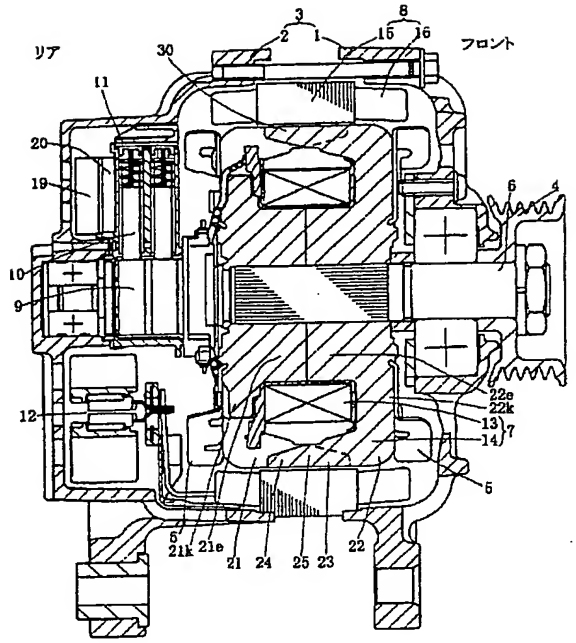
【図１４】



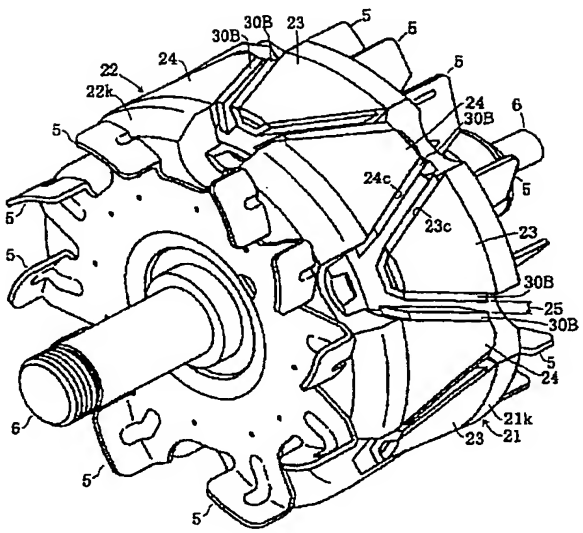
【図１８】



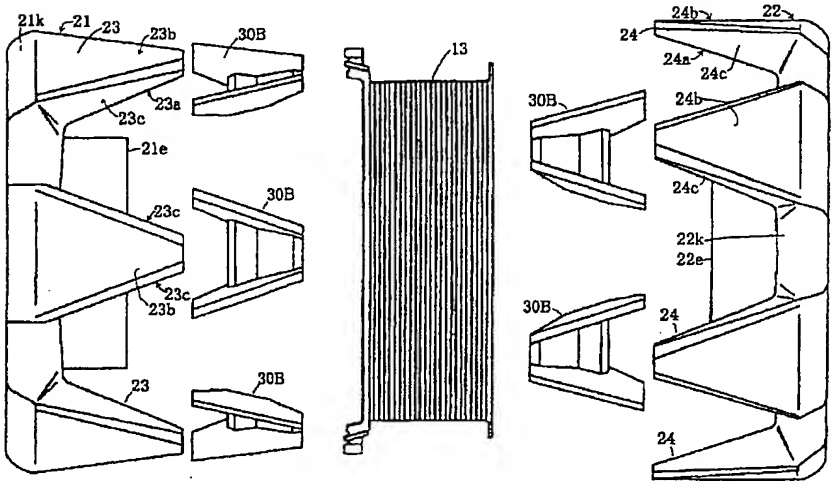
【図１７】



【図１９】



【図２０】



フロントページの続き

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Ｆターム(参考)　5H619 AA03 AA07 BB02 BB17 PP02
PP04 PP08

US006201335B1

(12) **United States Patent**
Higashino et al.

(10) **Patent No.: US 6,201,335 B1**
(45) **Date of Patent: Mar. 13, 2001**

(54) **ROTOR STRUCTURE**

(75) Inventors: **Kyoko Higashino; Yoshihito Asao; Kenji Tsuruhara; Atsushi Oohashi**, all of Tokyo (JP)

(73) Assignee: **Mitsubishi Denki Kabushiki Kaisha**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/531,223**

(22) Filed: **Mar. 20, 2000**

(30) **Foreign Application Priority Data**

Sep. 17, 1999 (JP) 11-264130

(51) **Int. Cl.**[7] **H02K 21/14**
(52) **U.S. Cl.** **310/263**; 310/156; 310/261
(58) **Field of Search** 310/263, 156, 310/257, 192, 261

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Primary Examiner—Burton Mullins
(74) *Attorney, Agent, or Firm*—Sughrue, Mion, Zinn, Macpeak & Seas, PLLC

(57) **ABSTRACT**

A rotor structure comprising a rotor coil for generating a magnetic flux, a pole core which covers the rotor coil and consists of a first pole core body and a second pole core body, each having a plurality of claw-like magnetic poles which are mated with each other, magnets provided on both sides of each of the claw-like magnetic pole for suppressing the leakage of a magnetic flux between adjacent claw-like magnetic poles, and reinforcements for holding the magnets in such a manner that the magnets are inclined so that the interval between the magnets becomes larger on the outer side than on the inner side.

This rotor structure can reduce centrifugal force applied to the magnets.

20 Claims, 14 Drawing Sheets

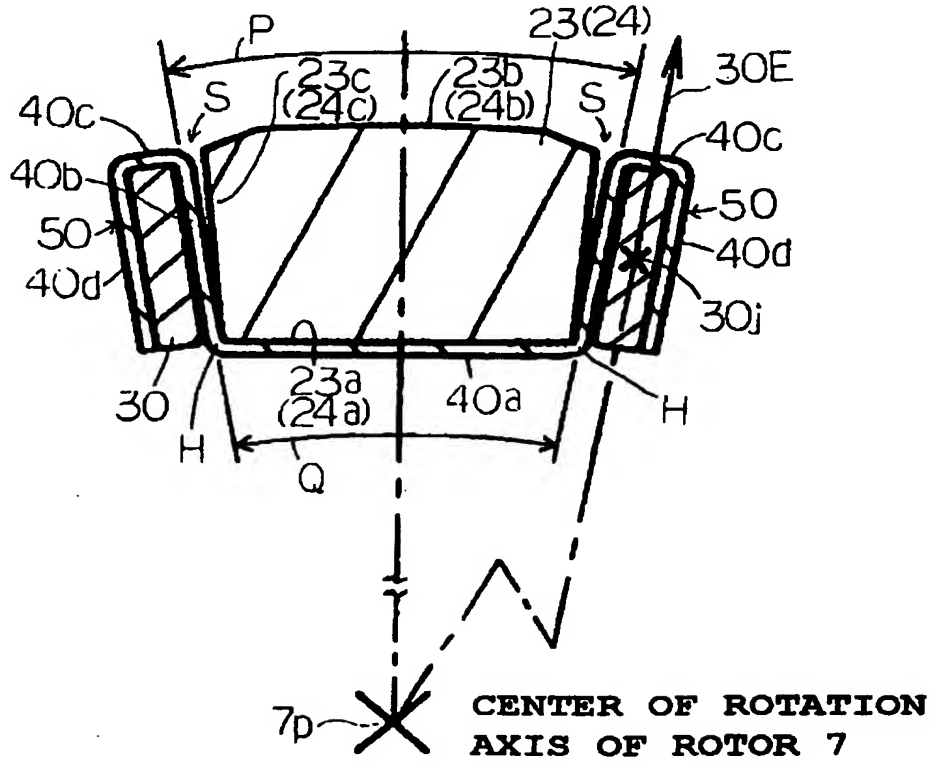


FIG. 1

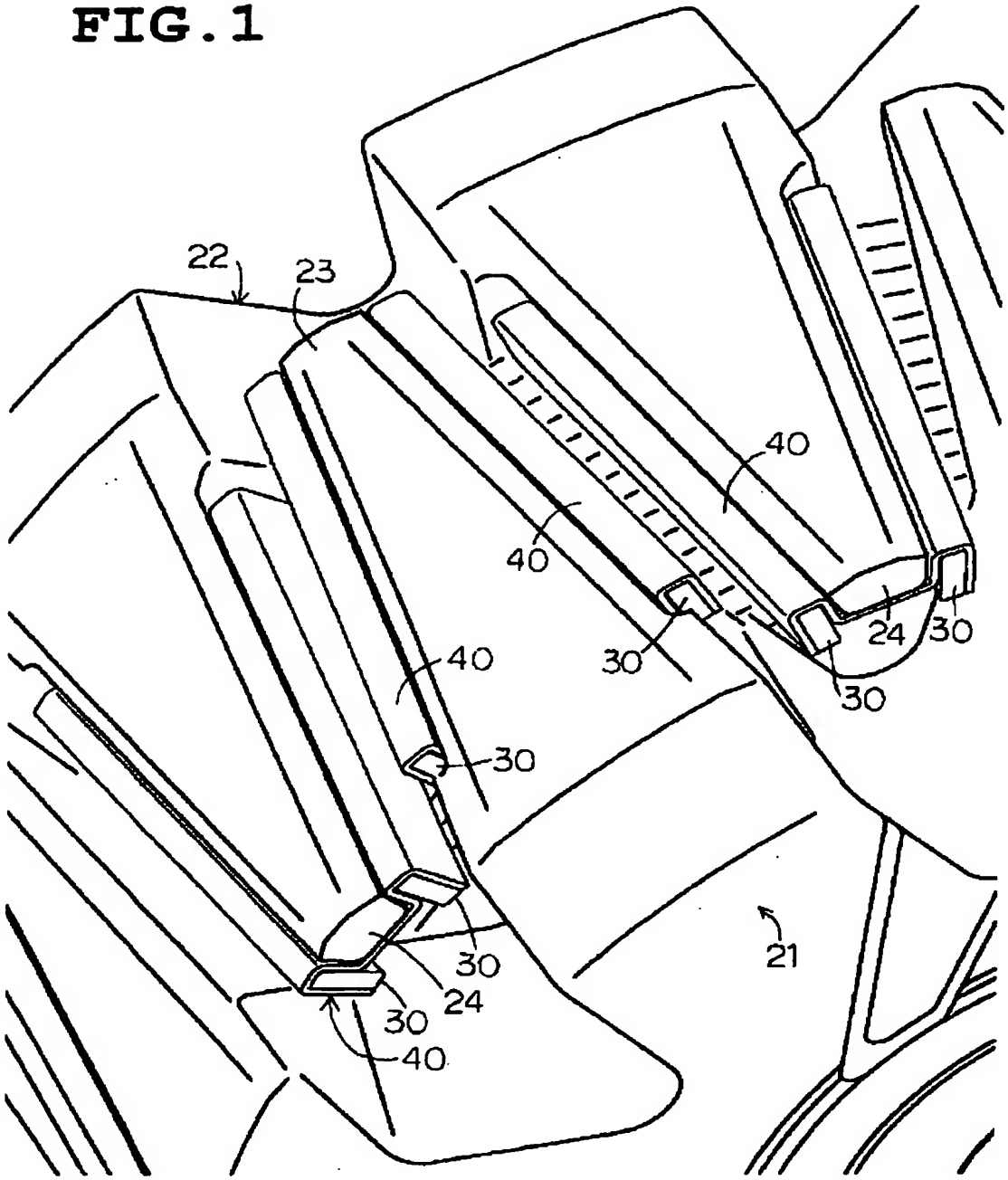


FIG. 2

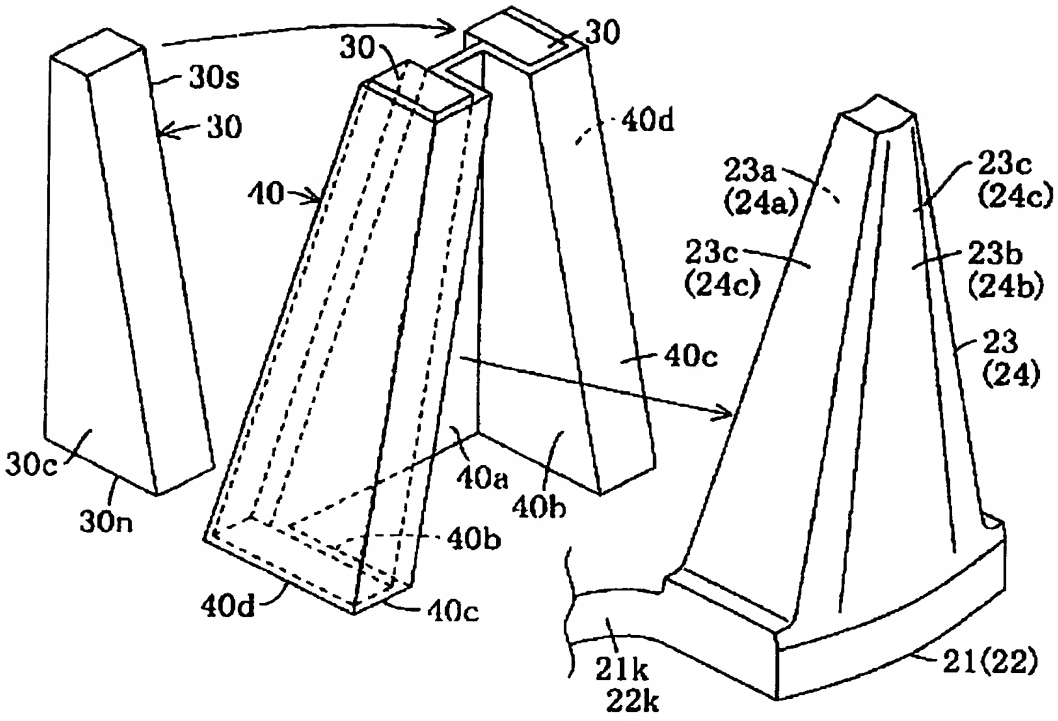

30
30
30s
30
40d
10
23a
(24a)
23c
(24c)
23c
(24c)
23b
(24b)
23
(24)
40c
30c
30n
40a
40b
40b
40d
40c
21k
22k
21(22)

FIG. 3

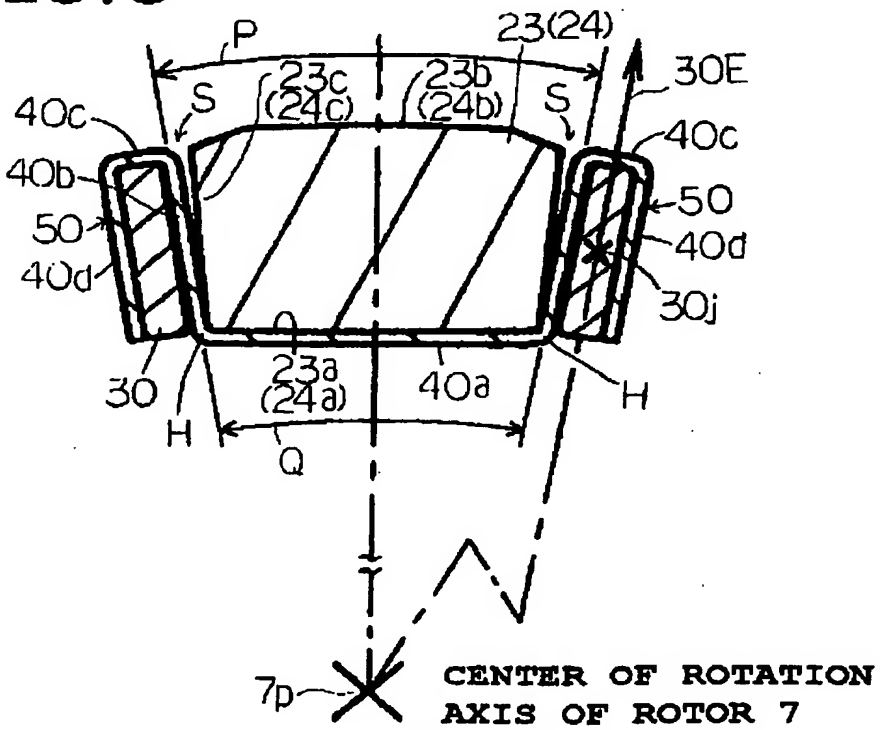

P
23(24)
30E
S
23c
(24c)
23b
(24b)
S
40c
40c
40b
50
50
40d
40d
30j
30
23a
(24a)
40a
H
H
Q
7p
CENTER OF ROTATION
AXIS OF ROTOR 7

FIG. 4

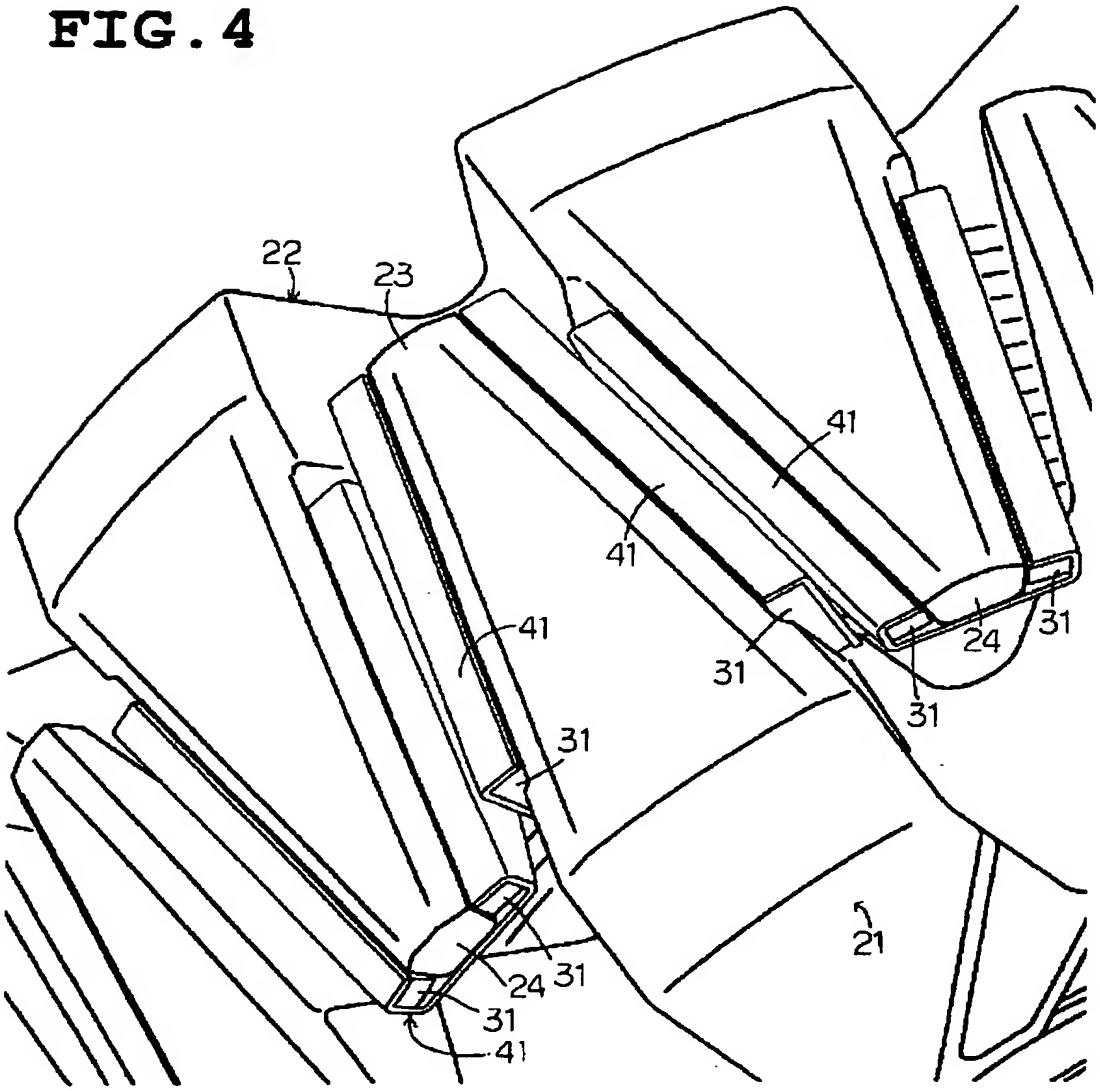


FIG. 5

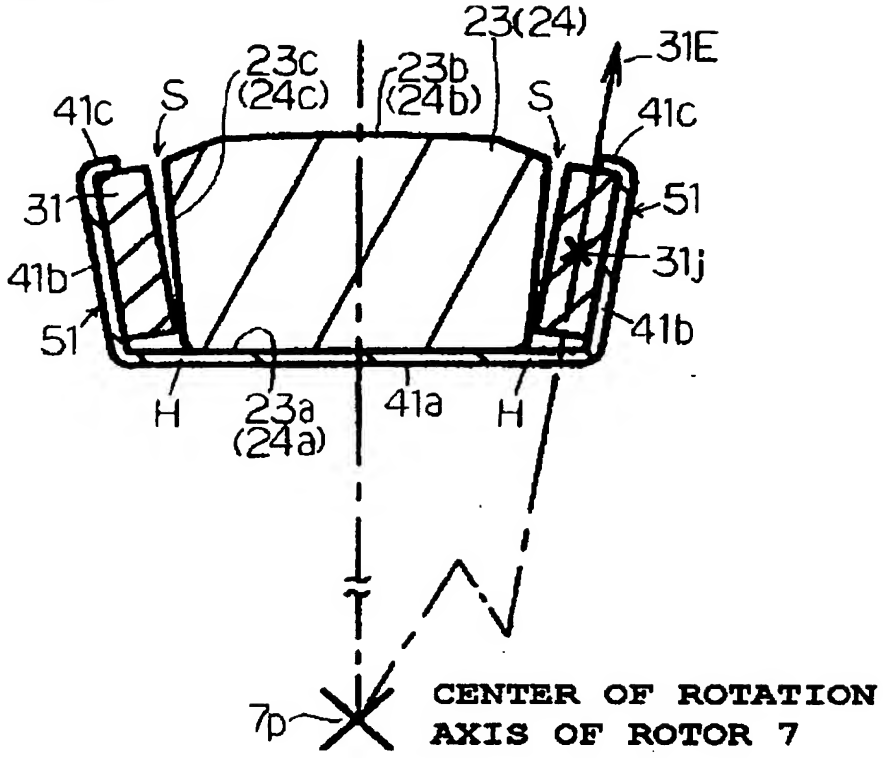

23(24)
31E
23c
(24c)
23b
(24b)
S
S
41c
41c
31
51
41b
31j
51
41b
H
23a
(24a)
41a
H
7p
CENTER OF ROTATION
AXIS OF ROTOR 7

FIG. 6

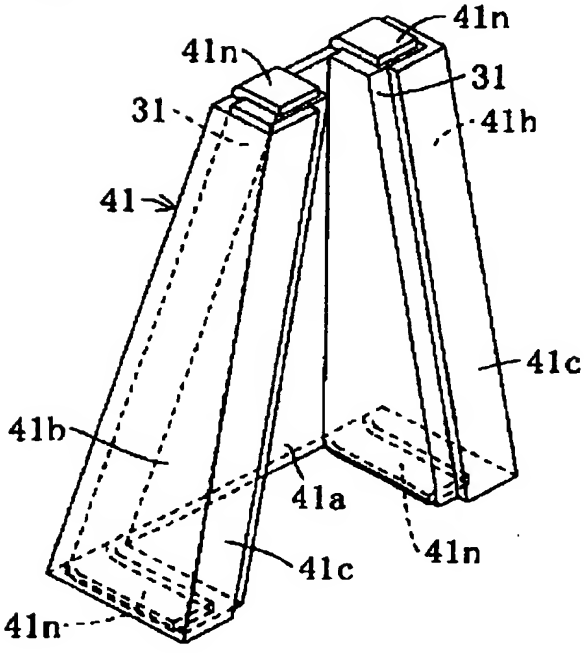
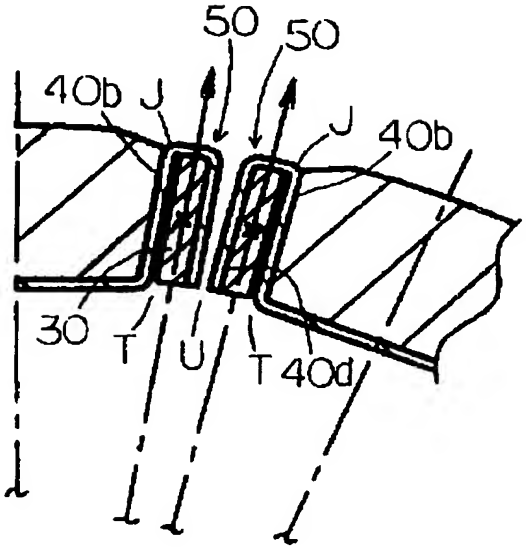
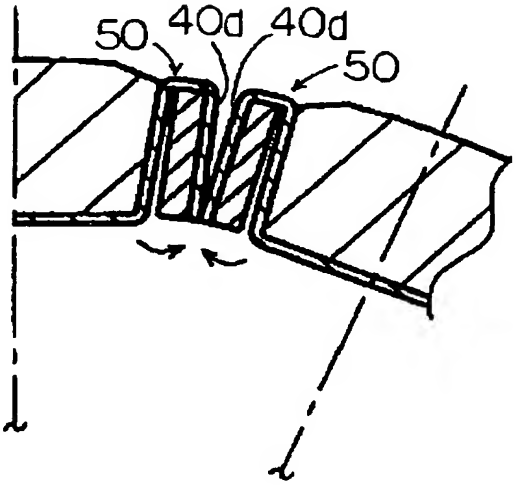

41n
41n
31
31
41h
41
41c
41b
41a
41c
41n
41n

FIG. 7 (a)



CENTER OF ROTATION AXIS OF ROTOR 7

FIG. 7 (b)



CENTER OF ROTATION AXIS OF ROTOR 7

FIG. 8

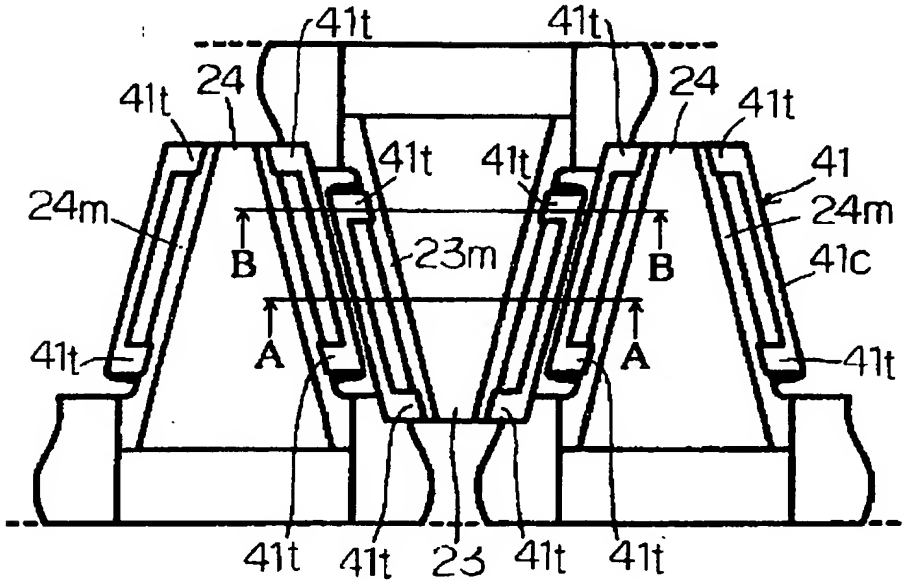
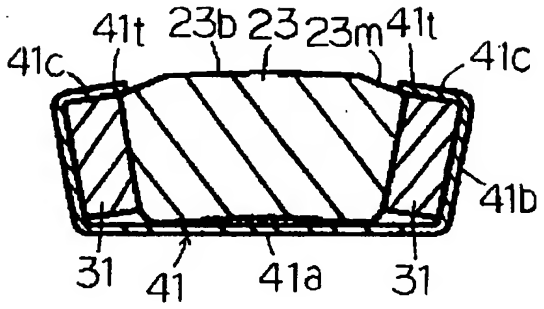
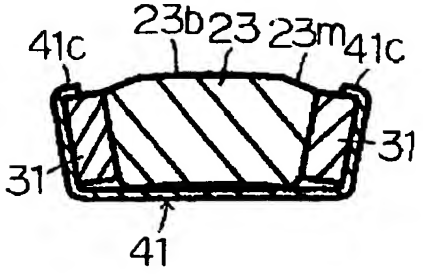


FIG. 9 (a)



B-B CROSS SECTION

FIG. 9 (b)



A-A CROSS SECTION

FIG. 10

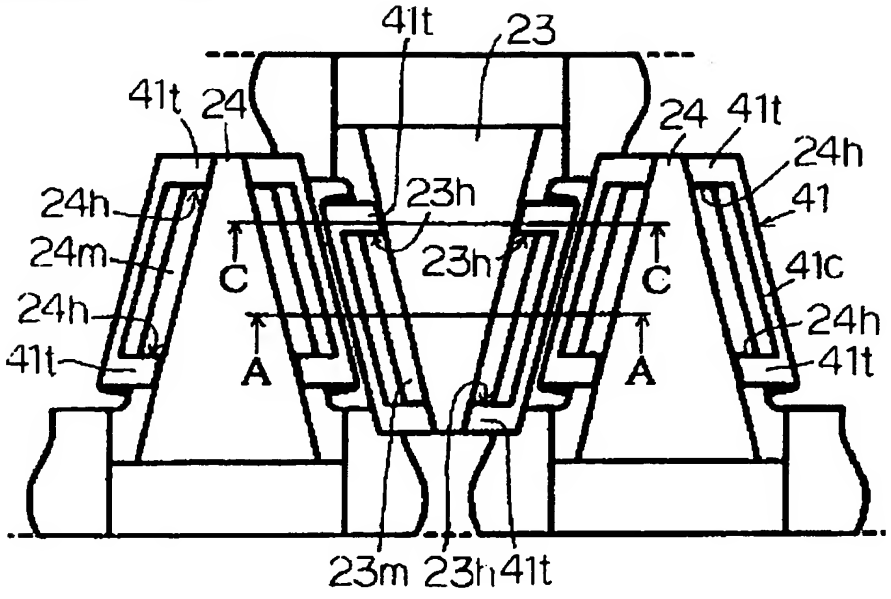
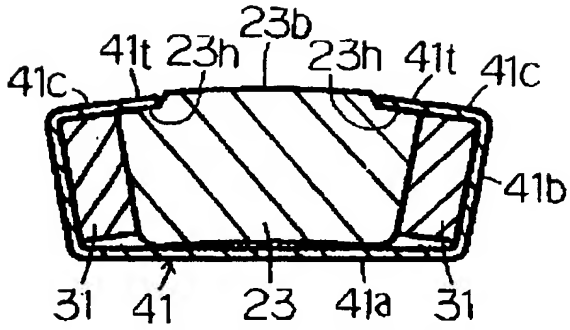
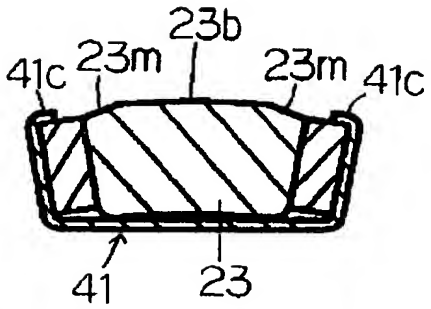


FIG. 11(a)



C-C CROSS SECTION

FIG. 11(b)



A-A CROSS SECTION

FIG. 12 (a)

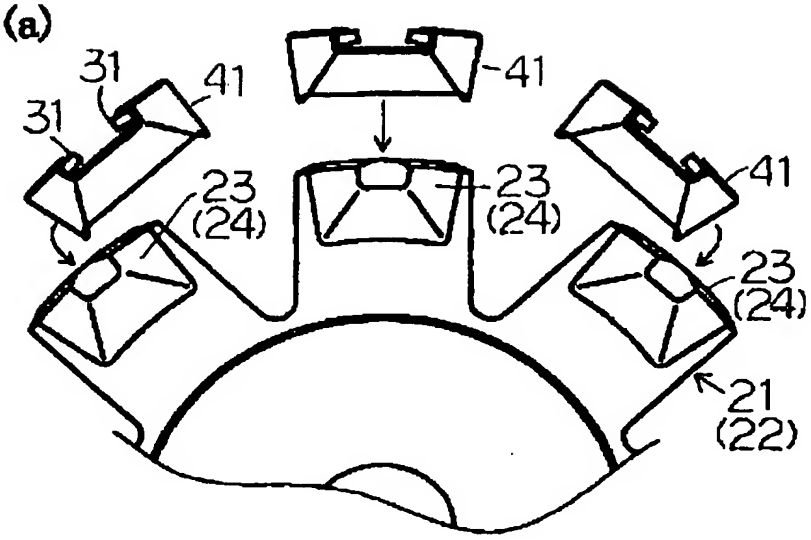


FIG. 12 (b)

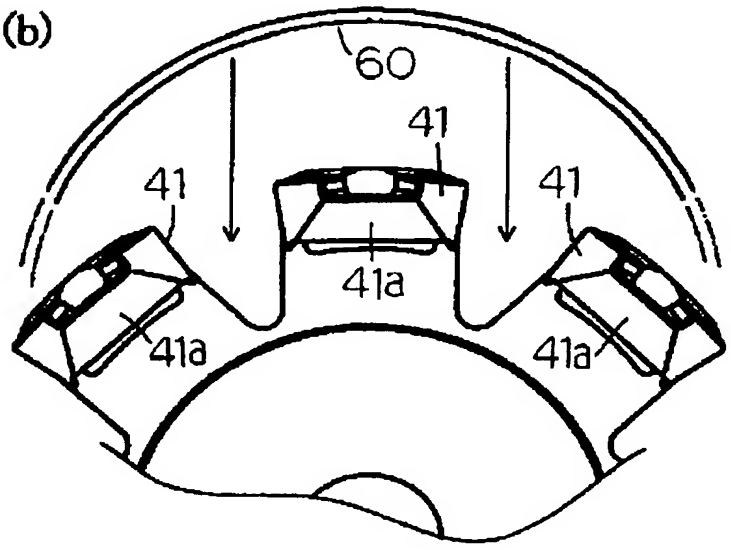


FIG. 12 (c)

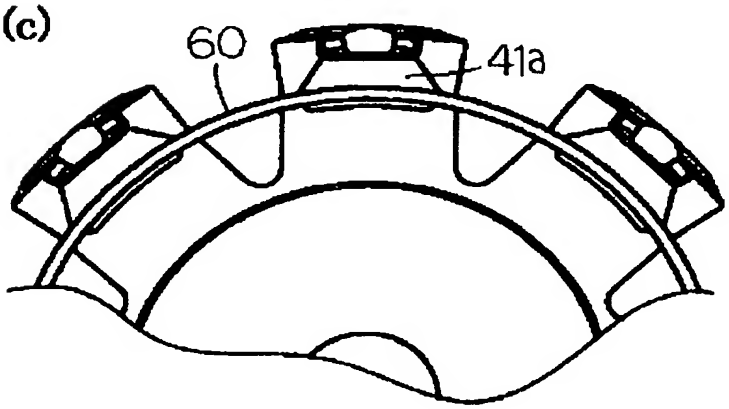


FIG. 13

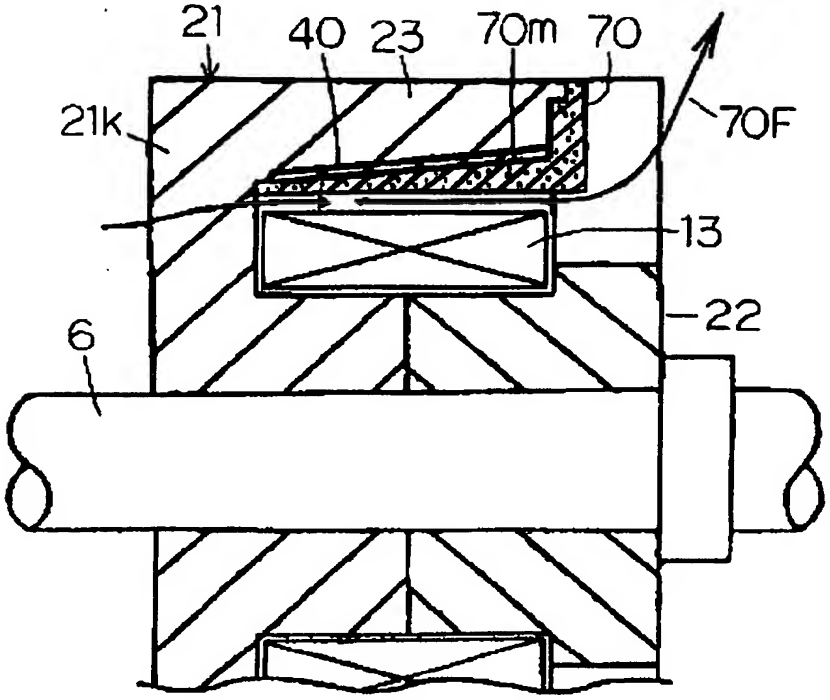


FIG. 14

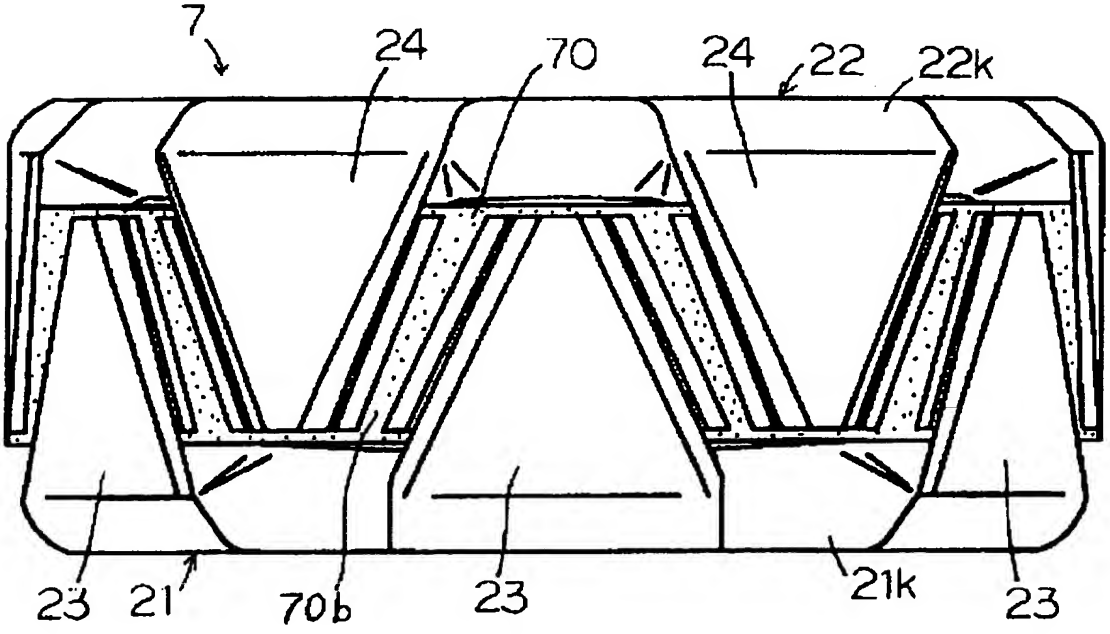


FIG. 15(a)

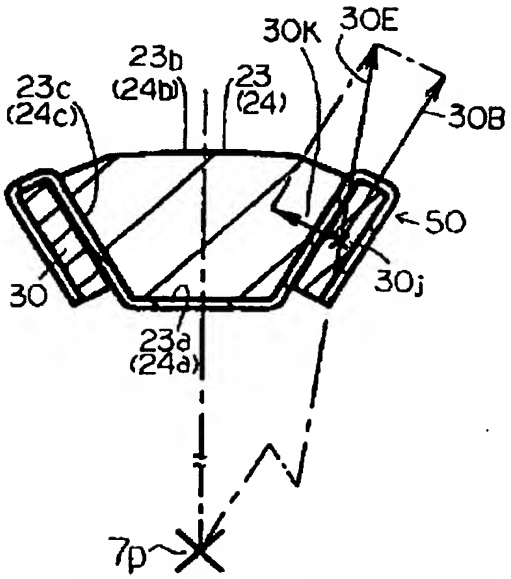


FIG. 15(b)

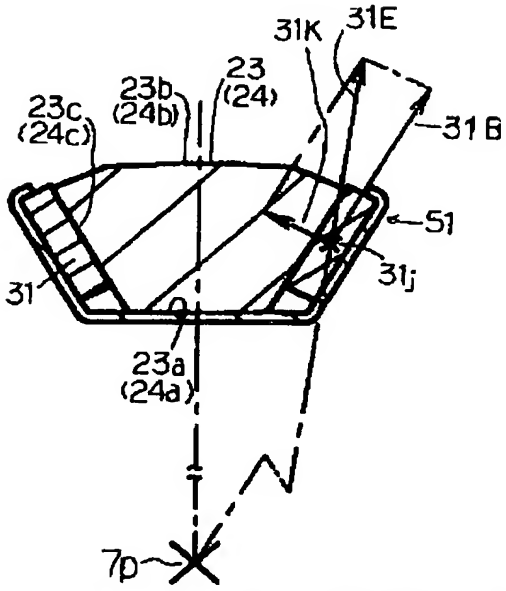


FIG. 16

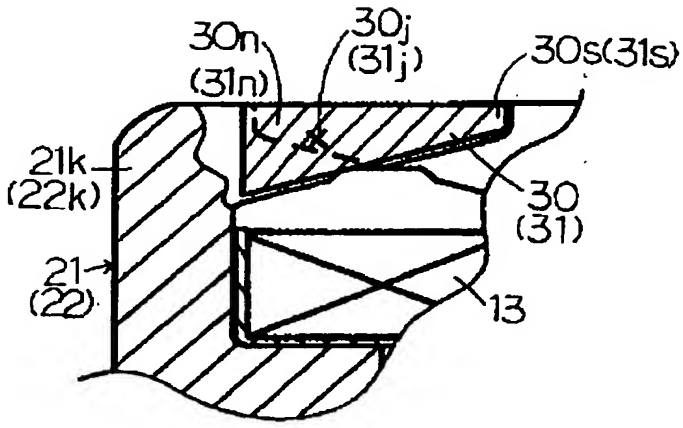


FIG. 17 PRIOR ART

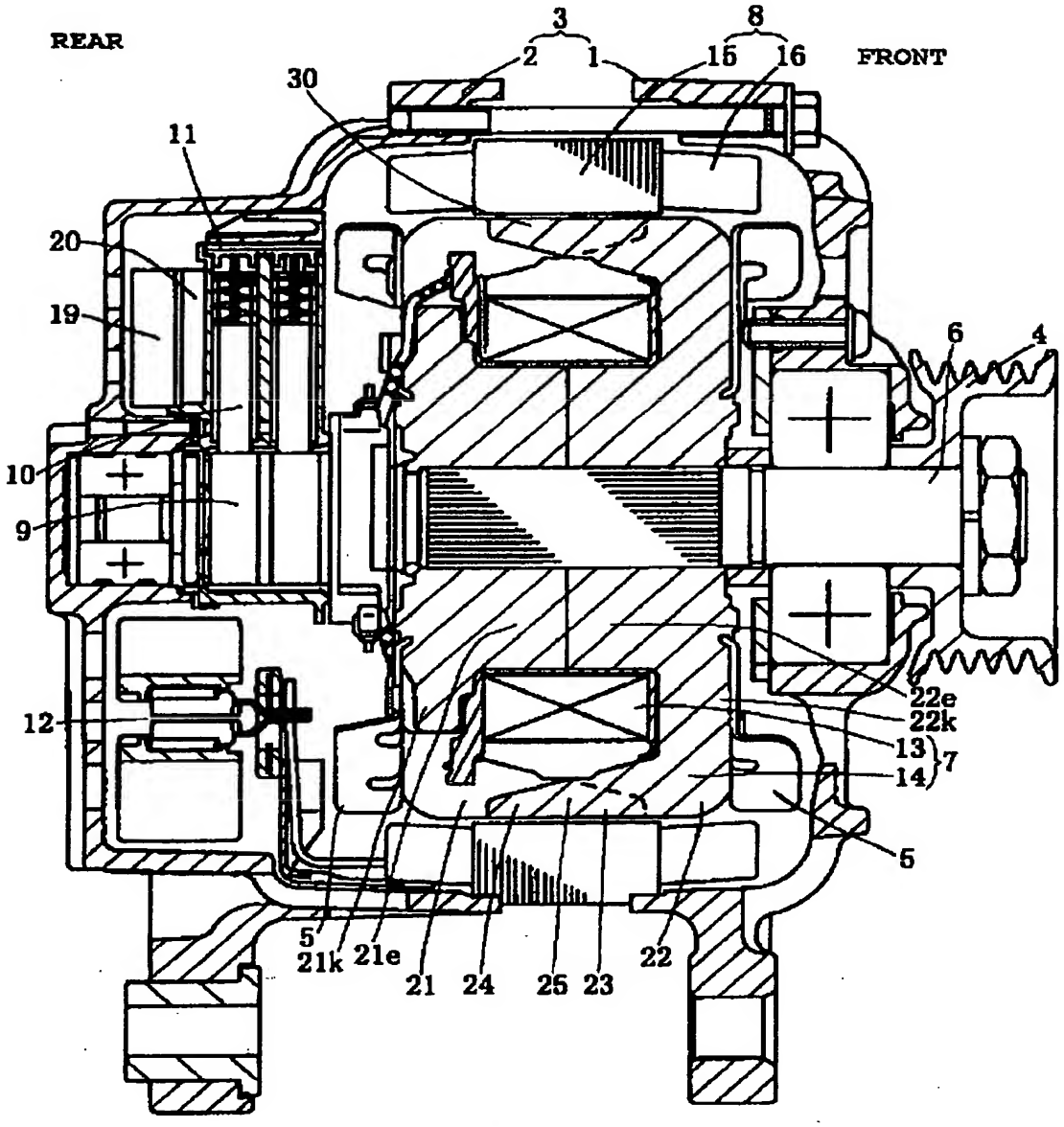


FIG. 18 PRIOR ART

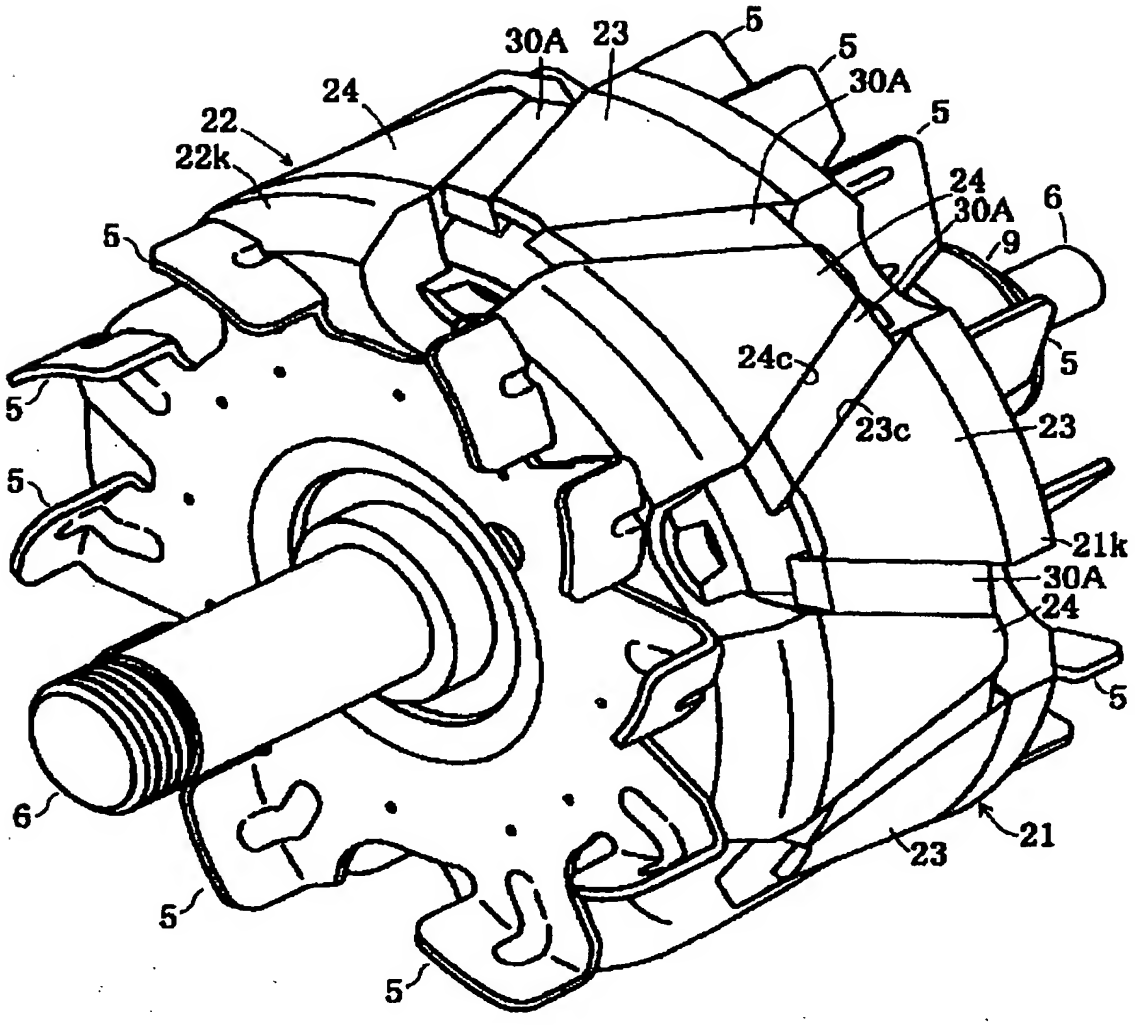
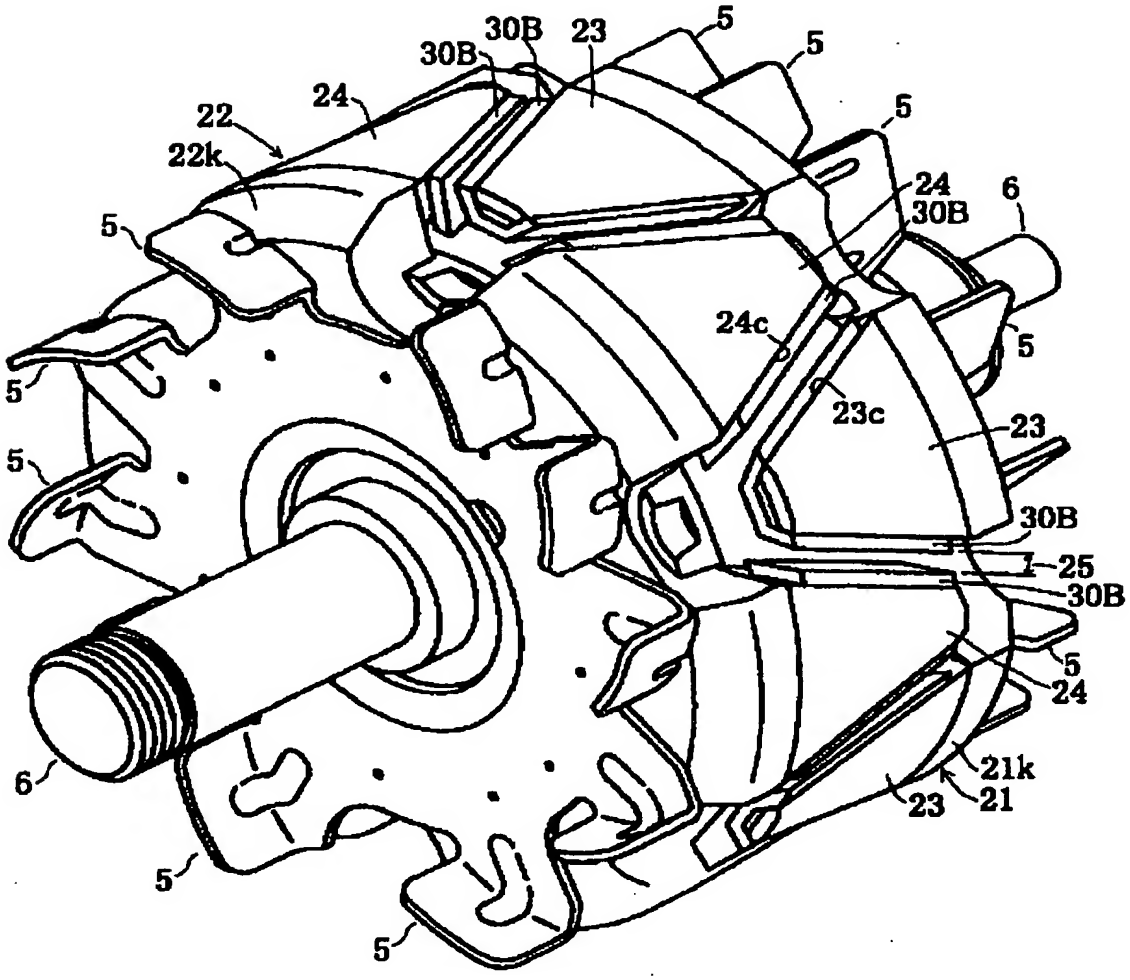


FIG.19 PRIOR ART



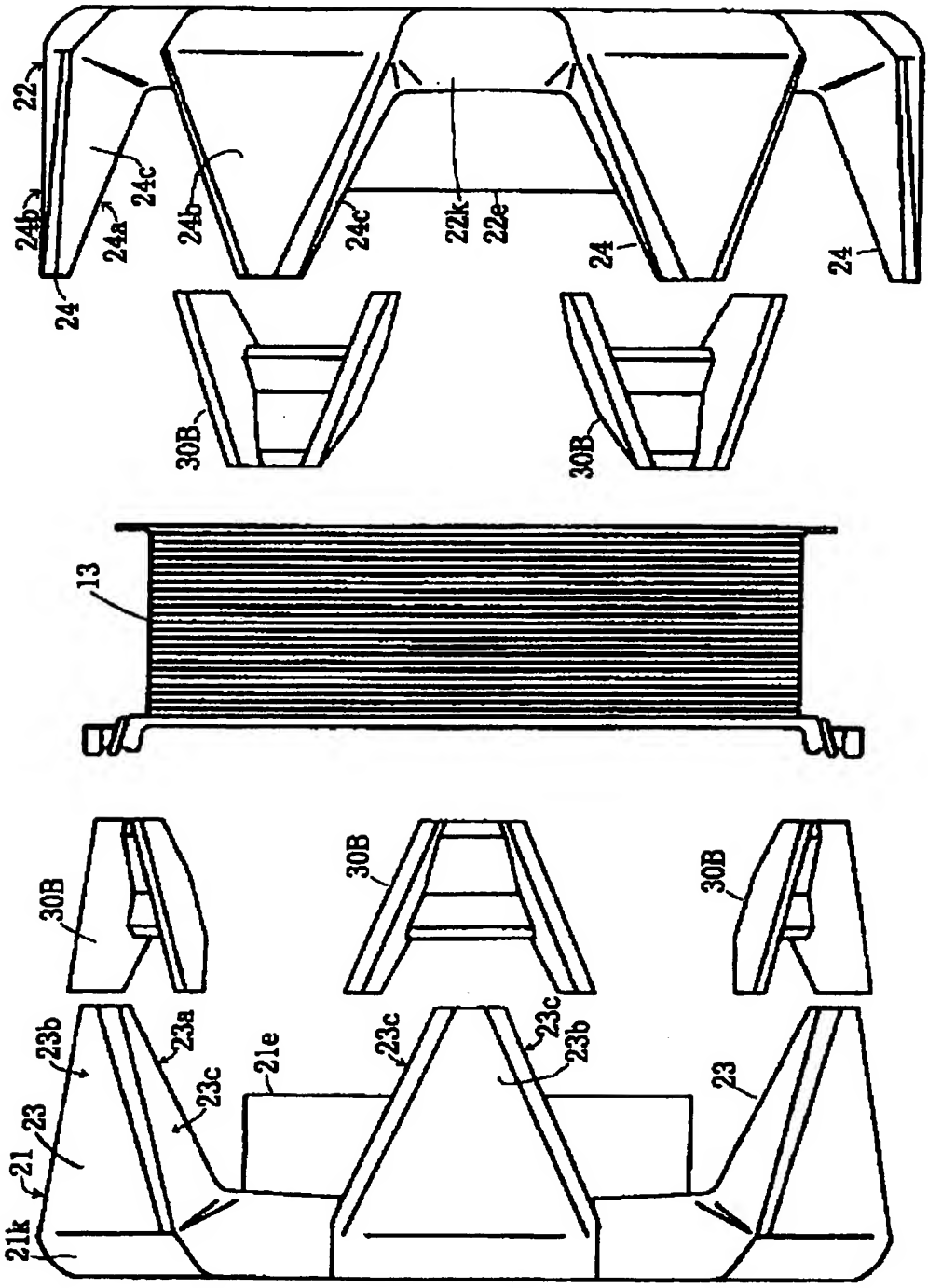


FIG. 20 PRIOR ART

ROTOR STRUCTURE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a rotor structure for an AC generator or a motor and, particularly, to a structure for attaching magnets for preventing the leakage of a magnetic flux between claw-like magnetic poles.

2. Description of the Prior Art

FIG. **17** is a sectional side view of a prior art rotor structure for an AC generator or a motor, FIG. **18** is a perspective view of the rotor, and FIG. **20** is an exploded side view of individual parts of the rotor.

As shown in FIG. **17**, this generator comprises a case **3** consisting of an aluminum front bracket **1** and an aluminum rear bracket **2**, a shaft **6** which is installed in the case **2** and one end of which is fitted with a pulley **4**, a Randle type rotor **7** fixed to the shaft **6**, fans **5** fixed to both end surfaces of the rotor **7**, a stator **8** fixed to the inner wall of the case **3**, slip rings **9** which are fixed to the other end of the shaft **6** and supply a current to the rotor **7**, a pair of brushes **10** in sliding contact with the slip rings **9**, a brush holder **11** for storing the brushes **10**, a rectifier **12** which is electrically connected to the stator **8** and rectifies an alternating current generated in the stator **8** into a direct current, a heat sink **19** attached to the brush holder **11**, and a regulator **20** which is attached to the heat sink **19** and regulates an AC voltage generated in the stator **8**.

The rotor **7** comprises a cylindrical rotor coil **13** for generating a magnetic flux with a current and a pole core **14** which covers the rotor coil **13** and forms a magnetic pole with the magnetic flux of the rotor coil **13**.

The stator **8** comprises a stator core **15** and a stator coil **16** which is wound round the stator core **15** and generates an alternating current by a change in magnetic flux from the rotor coil **13** caused by the rotation of the rotor **7**.

The pole core **14** consists of a first pole core body **21** and a second pole core body **22** which are mated with each other.

The pole core body **21** and the pole core body **22** are generally made from iron and consist of cylindrical portions **21***e* and **22***e* wound with the rotor coil **13** and disk-like base portions **21***k* and **22***k* from which the cylindrical portions **21***e* and **22***e* project, respectively. The base portions **21***k* and **22***k* have at the peripheries a plurality of claw-like magnetic poles **23** and **24** which are mated with each other between the outer wall of the rotor coil **13** and the inner wall of the stator **8**, respectively.

The thickness and width of each of the claw-like magnetic poles **23** and **24** are large on the base portion **21***k* and **22***k* sides and become smaller toward the end sides.

The inner faces **23***a* and **24***a* of the claw-like magnetic poles **23** and **24** become thinner toward the ends and the outer faces **23***b* and **24***b* are arched in conformity with the inner wall of the stator **8**. Each of the claw-like magnetic poles **23** and **24** has two trapezoidal side faces **23***c* and **24***c* in a circumferential direction of the rotor **7**. Since each pair of claw-like magnetic poles **23** and **24** are mated with each other, the inner faces **23***a* and **24***a* of the claw-like magnetic poles **23** and **24** are arranged alternately in a circumferential direction. The side faces **23***c* and **24***c* of the claw-like magnetic poles **23** and **24** are inclined toward the centers of the claw-like magnetic poles **23** and **24** so that they become thinner from the root side toward the end side.

As shown in FIG. **18**, a rectangular magnet **30A** magnetized to suppress the leakage of a magnetic flux between the opposed side faces **23***c* and **24***c* is fixed between the adjacent claw-like magnetic poles **23** and **24**.

A description is subsequently given of the operation of the generator. A current is supplied from an unshown battery to the rotor coil **13** through the brushes **10** and the slip rings **9** to generate a magnetic flux, whereby the claw-like magnetic poles **23** of the first pole core body **21** are magnetized to an N pole and the claw-like magnetic poles **24** of the second pole core body **22** are magnetized to an S pole. Meanwhile, the pulley **4** is turned by the rotation force of an engine and the rotor **7** is turned by the shaft **6**, thereby generating electromotive force in the stator coil **16**. This AC electromotive force is rectified into a direct current by the rectifier **12**, regulated by the regulator **20** and charged into the unshown battery.

The above magnet **30A** which is inserted between the claw-like magnetic poles **23** and **24** and is rectangular or may be various in shape, for example, ring-shaped or ring-shaped and packed in other resin is fixed to the claw-like magnetic poles **23** and **24** by fixing means.

However, the following problems may occur. That is, since stress is applied to the magnet **30A** at the time of production or centrifugal force generated by rotation is applied to the magnet **30A**, the magnet **30A** is inferior in durability.

Further, since the pole core bodies **21** and **22** are generally produced by forging, details of the claw-like magnetic poles **23** and **24** which have a specially complex shape cannot have high accuracy. There are differences in size between the claw-like magnetic poles **23** and **24**. It is difficult to manufacture the magnet **30A** which is formed in conformity with the inner faces **23***a* and **24***a* of the claw-like magnetic poles **23** and **24** which differ from each other and a support member which is molded in conformity with the claw-like magnetic poles **23** and **24**.

When the magnet **30A** is manufactured in consideration of molding ease, it becomes fragile. Therefore, when it is installed near the claw-like magnetic poles **23** and **24** of the rotor **7**, some measure is necessary. However, when the magnet **30A** is made sufficiently thick or very strong, it costs dear, making it difficult to mass-produce it.

Suppose that the magnet **30A** and the support member are produced in accordance with the differences and that differences in the gaps between the claw-like magnetic poles **23** and **24** and the magnet **30A** and between the claw-like magnetic poles **23** and **24** and the support member are made small. Even if the differences are small, when the magnet **30A** receives centrifugal force at the time of the rotation of the rotor **7**, a great force difference is produced, thereby making it possible that the magnet **30A** and the support member are damaged.

When the magnet **30A** is supported by the side faces **23C** and **24***c* of the claw-like magnetic poles **23** and **24** irrespective of the inner faces **23***a* and **24***a* of the claw-like magnetic poles **23** and **24**, force may be applied to the magnet **30A** by the dislocation of each of the two pole core bodies **21** and **22** when they are mated with each other or dislocation caused by rotation force.

The end portions of the claw-like magnetic poles **23** and **24** are moved toward the rotor coil **13** and the stator **8** by centrifugal force generated by the rotation of the rotor **7** and the magnetic attraction force of the stator **8** at the time of power generation. Thereby, a load is applied to the magnet **30A** between the claw-like magnetic poles **23** and **24**, whereby the magnet **30A** may be distorted or broken.

A countermeasure against this is disclosed by Japanese Laid-open Patent Application No. 11-136913. In this

publication, a magnet **30B** is formed as shown in FIG. **19** and FIG. **20**. That is, the magnet **30B** is fixed to each of the claw-like magnetic poles **23** and **24** in such a manner that it covers the inner face **23***a* or **24***a* and the side faces **23***c* or **24***c* of the claw-like magnetic pole **23** or **24**. A space **25** is formed between adjacent magnets **30B**. Thereby, a set of the claw-like magnetic pole **23** and the magnet **30B** and a set of the claw-like magnetic pole **24** and the magnet **30B** move independently, thereby preventing the application of a load to the magnet **30B** and the breakage of the magnet **30B**.

SUMMARY OF THE INVENTION

However, the invention disclosed by Japanese Laid-open Patent Application No. 11-136913 is not aimed to reduce the influence of centrifugal force generated by the rotation of the rotor **7** upon the magnet **30B**.

That is, since the magnet **30B** which moves together with the claw-like magnetic poles **23** and **24** is more fragile than the claw-like magnetic poles **23** and **24**, the magnet **30B** has low durability against centrifugal force. Further, since the magnet **30B** is completely exposed, it is conceivable that it may be damaged by a suspending substance contained in the case **3**. Further, as the magnet **30B** is fixed to the claw-like magnetic poles **23** and **24** by the uneven surface of the magnet **30B**, it is unsatisfactory in terms of strength against rotation.

A support member such as a tape is wound round each of the claw-like magnetic poles **23** and **24** to absorb centrifugal force applied to the magnet **30B**. This does not take into consideration the movement of the magnet **30B** during rotation and hence, the magnet **30B** cannot be always held properly by the tape. That is, the weight of the support member is applied to the magnet **30B** by the rotation of the rotor **7**, or the magnet **30B** is supported nonuniformly, whereby not only the magnet **30***o*A but also the support member may be broken at the time of high-speed rotation.

When the side faces **23***c* and **24***c* of the claw-like magnetic poles **23** and **24** are inclined in an axial direction or in a radial direction, the magnet **30B** fixed to the claw-like magnetic poles **23** and **24** is also inclined. When the magnet **30B** is to be fixed, it may be inclined toward the center of the axis or get out of place. Therefore, the magnet **30B** must be temporarily positioned to prevent this, thereby taking time and labor to fix. When the two pole core bodies **21** and **22** are to be mated with each other in such a manner that they surround the rotor coil **13**, the magnets **30B** for either one of the claw-like magnetic poles **23** and **24** are inclined and dropped. Further, when the shaft **6** is installed in the case and the generator is carried, there is a possibility that the magnets **30B** may fall off toward the center of the axis.

When an adhesive is applied to the magnets **30** in order to temporarily fix the magnets **30** to the claw-like magnetic poles **23** and **24** at this point, it is known that it is good to apply force for bringing adhesion surfaces close to each other in order to secure the positional relationship between them before drying and fixing. In this respect, force is readily applied to the above claw-like magnetic poles **23** and **24** and the above magnets **30** in such a direction that they are separated from each other, and a holding step is further required in the step of coating an adhesive, thereby making it possible that the assembly work becomes very complicated and cost becomes high. If some trouble occurs during this, when a rotor structure is used as a car AC generator which is used in a severe environment such as high temperatures or low temperatures for a long time, bonding portions between the claw-like magnetic poles **23** and **24** and the magnets **30B** may deteriorate with the result that the magnets **30** may be scattered.

It is an object of the present invention which has been made to solve the above problems to reduce centrifugal force applied to magnets for suppressing the leakage of a magnetic flux between claw-like magnetic poles at the time of rotation of the rotor and to attach the magnets to the claw-like magnetic poles.

According to a first aspect of the present invention, there is provided a rotor structure comprising a rotor coil for generating a magnetic flux, a pole core which covers the rotor coil and consists of a first pole core body and a second pole core body, each having a plurality of claw-like magnetic poles which are mated with each other, magnets provided on both sides of each claw-like magnetic pole to suppress the leakage of a magnetic flux between the side faces of adjacent claw-like magnetic poles, and reinforcements for holding the magnets in such a manner that the magnets are inclined so that the interval between the magnets becomes larger on the outer side than on the inner side.

According to a second aspect of the present invention, there is provided a rotor structure, wherein the reinforcement consists of an inner portion conformed to the inner face of the claw-like magnetic pole, bent portions bent from both ends of the inner portion toward the side faces of the claw-like magnetic pole, pressing portions, bent from the bent portions, for pressing the outer faces of the magnets, and folded portions folded from the pressing portions toward the side faces of the magnets, and the magnets are held on the inner side of the reinforcement.

According to a third aspect of the present invention, there is provided a rotor structure, wherein the reinforcement consists of an inner portion conformed to the inner face of the claw-like magnetic pole and the inner faces of the magnets, bent portions bent from both ends of the inner portion toward the side faces of the magnets, and pressing portions, projecting from the bent portions toward the claw-like magnetic pole, for pressing the outer faces of the magnets, and the magnets are held on the outer side of the reinforcement.

According to a fourth aspect of the present invention, there is provided a rotor structure, wherein the magnet and portions holding the magnet of the reinforcement constitute a side magnet body, a space is formed between the side magnet body and the side face of the claw-like magnetic pole, the side magnet body moves toward the claw-like magnetic pole to reduce the space when centrifugal force is applied to the magnet, and the reinforcement is deformed by this moving force to absorb the centrifugal force.

According to a fifth aspect of the present invention, there is provided a rotor structure, wherein the center of the movement of the side magnet body is located on the claw-like magnetic pole side of a line connecting the center of the rotation axis of the rotor and the gravity center of the magnet, and the movement of the side magnet body is stopped when it contacts the side face of the claw-like magnetic pole.

According to a sixth aspect of the present invention, there is provided a rotor structure, wherein the magnet is held by the pressing portion and the folded portion and constitutes a side magnet body together with the pressing portion and the folded portion, a space is formed between the side magnet body and the side face of the claw-like magnetic pole, a space is formed between adjacent side magnet bodies, the side magnet body moves toward the adjacent side magnetic body to reduce the space between the adjacent side magnet

bodies when centrifugal force is applied to the magnet, the reinforcement is deformed by this moving force to absorb the centrifugal force, and the movement of the side magnet body is stopped when the adjacent folded portions contact each other.

According to a seventh aspect of the present invention, there is provided a rotor structure, wherein the space between the side magnet body and the side face of the claw-like magnetic pole is set such that the deformed reinforcement can restore its original shape when centrifugal force is not applied to the magnet after the movement of the side magnet body is stopped and the deformation amount of the reinforcement becomes maximum.

According to an eighth aspect of the present invention, there is provided a rotor structure, wherein the space between the side magnet body and the side face of the claw-like magnetic pole is set such that stress applied to the reinforcement falls below at least an allowable level when the movement of the side magnet body is stopped and the deformation amount of the reinforcement becomes maximum.

According to a ninth aspect of the present invention, there is provided a rotor structure, wherein an elastic material is placed in the space between the side magnet body and the side face of the claw-like magnetic pole.

According to a tenth aspect of the present invention, there is provided a rotor structure which has a stopping structure for preventing the reinforcement from falling off from the claw-like magnetic pole in an inward direction.

According to an eleventh aspect of the present invention, there is provided a rotor structure which has a stopping structure for preventing the reinforcement from falling off from the claw-like magnetic pole in an outward direction.

According to a twelfth aspect of the present invention, there is provided a rotor structure which has a stopping structure for preventing the reinforcement from falling off from the claw-like magnetic pole in inward and outward directions.

According to a thirteenth aspect of the present invention, there is provided a rotor structure, wherein the above stopping structure is contacting portions which project from the reinforcement and contact the outer face of the claw-like magnetic pole.

According to a fourteenth aspect of the present invention, there is provided a rotor structure, wherein a pressing member for pressing the reinforcements against the claw-like magnetic poles from the inner side is used as the stopping structure.

According to a fifteenth aspect of the present invention, there is provided a rotor structure, wherein the pressing member has a cylindrical peripheral surface, grooves in which the claw-like magnetic poles held in the reinforcements are fitted in are formed in the peripheral surface, and the outer faces of the claw-like magnetic poles and the peripheral surface of the pressing member form the cylindrical curved peripheral surface of the rotor.

According to a sixteenth aspect of the present invention, there is provided a rotor structure, wherein the side faces of the claw-like magnetic pole are inclined such that the interval between them becomes larger on the outer side than on the inner side.

According to a seventeenth aspect of the present invention, there is provided a rotor structure, wherein the gravity center of the magnet is located close to the root side of the claw-like magnetic pole.

According to an eighteenth aspect of the present invention, there is provided a rotor structure, wherein the reinforcement is made from a metal.

According to a nineteenth aspect of the present invention, there is provided a rotor structure, wherein the reinforcement is welded to the claw-like magnetic pole.

According to a twentieth aspect of the present invention, there is provided a rotor structure, wherein the reinforcement has a stopping structure for preventing the magnets from falling off toward the end side or root side of the reinforcement.

The above and other objects, features and advantages of the invention will become more apparent from the following description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** is a perspective view of key parts of a rotor structure according to Embodiment 1 of the present invention;

FIG. **2** is an exploded perspective view of the key parts of the rotor structure according to Embodiment 1;

FIG. **3** is a sectional view in an axial direction of a claw-like magnetic pole, a reinforcement and magnets according to Embodiment 1;

FIG. **4** is a perspective view of key parts of a rotor structure according to Embodiment 2;

FIG. **5** is a sectional view in an axial direction of a claw-like magnetic pole, a reinforcement and magnets according to Embodiment 2;

FIG. **6** is a perspective view of the stopping portions of the reinforcement according to Embodiment 2;

FIGS. **7**(*a*) and **7**(*b*) are sectional views in an axial direction of a claw-like magnetic pole, a reinforcement and magnets according to Embodiment 3;

FIG. **8** is a schematic side view of contacting portions according to Embodiment 4;

FIGS. **9**(*a*) and **9**(*b*) are sectional views in an axial direction of a claw-like magnetic pole and contacting portions of a reinforcement and magnets according to Embodiment 4;

FIG. **10** is a schematic side view of stepped portions according to Embodiment 5;

FIGS. **11**(*a*) and **11**(*b*) are sectional views in an axial direction of stepped portions of a claw-like magnetic pole, contacting portions of a reinforcement and magnets according to Embodiment 5;

FIGS. **12**(*a*), **12**(*b*) and **12**(*c*) are plan views of a pressing member set on reinforcements according to Embodiment 6;

FIG. **13** is a sectional view in an axial direction of a pressing member according to Embodiment 7;

FIG. **14** is a side view of a pressing member and a rotor according to Embodiment 7;

FIGS. **15**(*a*) and **15**(*b*) are sectional views in an axial direction of the side faces of a claw-like magnetic pole, a reinforcement and magnets according to Embodiment 8;

FIG. **16** is a sectional view in a circumferential direction of a claw-like magnetic pole and magnets according to Embodiment 9;

FIG. **17** is a sectional view of a car AC generator for explaining a prior art rotor structure;

FIG. **18** is a perspective view for explaining a prior art rotor structure;

FIG. 19 is a perspective view for explaining a prior art rotor structure; and

FIG. 20 is an exploded side view for explaining a prior art rotor structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described herein under with reference to the accompanying drawings.

Embodiment 1

FIGS. 1 to 3 show a rotor structure for use in a car AC generator according to Embodiment 1 of the present invention. FIG. 1 is a perspective view of key parts of a rotor for a car AC generator, FIG. 2 is an exploded perspective view and FIG. 3 is a sectional view of a reinforcement. The same and corresponding elements as those of FIGS. 17 to 20 are given the same reference symbols.

As shown in FIG. 1, a ferrite magnet **30** magnetized to suppress the leakage of a magnetic flux between claw-like magnetic poles **23** and **24** is provided on both side faces **23***c* and **23***c* of each claw-like magnetic pole **23** and both side faces **24***c* and **24***c* of each claw-like magnetic pole **24**.

The magnets **30** are held to the claw-like magnetic pole **23** or **24** by a reinforcement **40** which is deformed to absorb centrifugal force applied to the magnets **30** at the time of rotation of a rotor **7** in such a manner they are inclined so that the interval between the magnets **30** becomes larger on the outer side than on the inner side. The reinforcement **40** is made of a metal plate such as a stainless steel plate having a thickness of about 0.5 mm and easily manufactured by bending a single metal plate by pressing.

As shown in FIG. 2 and FIG. 3, this reinforcement **40** has a substantially M-shaped cross section in an axial direction of the rotor **7** and consists of a trapezoidal inner portion **40a** conformed to the inner face **23***a* or **24***a* of the claw-like magnetic pole **23** or **24**, bent portions **40***b* bent outward from both ends of the inner portion **40***a* and conformed to both side faces **23***c* or **24***c* of the claw-like magnetic pole **23** or **24**, pressing portions **40***c* bent from the ends of the bent portions **40***b* toward the outer faces of the magnets **30** and pressing the outer faces of the magnets **30**, and folded portions **40***d* folded from the pressing portions **40***c* toward the side faces of the magnets **30**.

The magnets **30** are surrounded by the bent portions **40***b*, the pressing portions **40***c* and the folded portions **40***d* and sandwiched between the bent portions **40***b* and the folded portions **40***d* to hold them on the inner side of the reinforcement **40** from the outer side.

As shown in FIG. 3, the inner portion **40***a* and the bent portions **40***b* and **40***b* at both ends of the inner portion **40***a* form an almost U shape in such a manner that the bent portions **40***b* and **40***b* are inclined so that the length Q on the inner side becomes smaller than the length P on the outer side. The bent portions **40***b*, the pressing portions **40***c* and the folded portions **40***d* of the reinforcement **40** surrounding the magnets **30** form an inverted U shape in conformity with the cross section of the magnet **40**.

That is, the magnets **30** are provided on both side faces **23***c* or **24***c* of the claw-like magnetic pole **23** or **24** in such a manner that they are inclined from the center line of the claw-like magnetic pole **23** or **24** passing through the center **7***p* of the rotation axis of the rotor **7** toward the outer face **23***b* or **24***b*.

As shown in FIG. 2, the magnet **30** does not require a holding portion for the claw-like magnetic pole **23** or **24**, and the side faces **30***c* of the magnet are trapezoidal in conformity with the side face **23***c* or **24***c* of the claw-like magnetic pole **23** or **24**. The magnet **30** is shaped like a headed quadrangular pyramid whose width is almost fixed and thickness increases from the end **30***s* side toward the root **30***n* side in conformity with the shape of the claw-like magnetic pole **23** or **24**. The magnet **30** may be rectangular.

An adhesive or the like is used to hold the magnet **30** by the reinforcement **40** and fix it to the claw-like magnetic pole **23** or **24**. That is, the boundary between the inner portion **40***a* of the reinforcement **40** and the inner face **23***a* or **24***a* of the claw-like magnetic pole **23** or **24** and the boundary between the bent portion **40***b*, pressing portion **40***c* and folded portion **40***d* of the reinforcement **40** and the magnet **30** are coated with an adhesive.

To fix the magnet **30** to the claw-like magnetic pole **23** or **24**, the side face **23***c* or **24***c* of the claw-like magnetic pole **23** or **24** is separated from the bent portion **40***b* of the reinforcement **40** with a small space S therebetween.

By this constitution, centrifugal force **30**E applied to the gravity center **30***j* of the magnet **30** at the time of the rotation of the rotor **7** in FIG. **3** becomes moment for moving the magnet **30** and portions holding the magnet **30** of the reinforcement **40** and is absorbed by the reinforcement **40**. A set of the magnet **30** and the portions holding the magnet **30** of the reinforcement **40** (bent portion **40***b*, pressing portion **40***c* and folded portion **40***d*) is called "side magnet body **50**" and moment applied to the side magnet body **50** will be described with reference to FIG. **3**.

That is, the side magnet body **50** is supported only at one side because its fulcrum H is located at each end of the inner portion **40***a* of the reinforcement **40**. That is, the fulcrum H is located on the claw-like magnetic pole **23** or **24** side of a line connecting the center **7***p* of the rotation axis of the rotor **7** and the gravity center **30***j* of the magnet **30**. Thereby, centrifugal force **30**E applied to the magnet **30** is applied to the reinforcement **40** as the above moment. The direction of the above moment applied to the side magnet body **50** is the center direction of the reinforcement **40**, that is, the center direction of the claw-like magnetic pole **23** or **24** with the fulcrum H as the center of the movement.

Therefore, the outer side of the side magnet body **50** moves and displaces toward the side face **23***c* or **24***c* of the claw-like magnetic pole **23** or **24**. Stress is applied to the reinforcement **40** by this displacement but the reinforcement **40** is not broken because the above small space S is formed to reduce the stress to a level below an allowable level. In this case, this small space S is set such that the reinforcement **40** restores its original shape when centrifugal force **30**E is not applied to the magnet **30** any more after the displacement of the reinforcement **40**.

Thereby, the reinforcement **40** holds the claw-like magnetic pole **23** or **24**, thereby increasing its holding strength with the result that the connection of the magnet **40** and the claw-like magnetic pole **23** or **24** is promoted.

When the end portion of the claw-like magnetic pole **23** or **24** is moved inward or outward at the time of the rotation of the rotor **7**, it is possible that the end portion of the side magnet body **50** is moved outward by the spring-back of the reinforcement **40**. However, the displacement of the side magnet body **50** by the above moment occurs in a direction which offsets the above spring-back, thereby making it possible to eliminate such inconvenience that the magnet **30** and the reinforcement **40** fall off from the claw-like magnetic pole **23** or **24**.

Since the inner face 23*a* or 24*a* of the claw-like magnetic pole 23 or 24 is in contact with the inner portion 40*a* of the reinforcement 40, heat transmitted to the claw-like magnetic poles 23 and 24 at the time of power generation is radiated by the reinforcement 40. However, the main purpose of Embodiment 1 is to reduce centrifugal fore 30E applied to the magnet 30.

The inner face facing the rotor coil 13 of the magnet 30 held by the reinforcement 40 is exposed so that heat generated at the time of power generation is radiated therefrom. Since the remaining three faces of the magnet 30 are almost surrounded by the reinforcement 40, the magnet 30 has high resistance to centrifugal force. Even if a suspending substance should hit the magnet 30 from the outer side, as the magnet 30 is covered with the reinforcement 40, it is not damaged.

The magnet 30 is not chipped at the time of assembly because it is attached to the claw-like magnetic pole 23 or 24 while it is covered with the reinforcement 40 and has no faces in contact with the claw-like magnetic pole 23 or 24.

Although a cut-away portion in which the reinforcement 40 is fitted is formed in the side faces 23*c* and 24*c* of the claw-like magnetic poles 23 and 24, the claw-like magnetic poles 23 and 24 are the same as those of the prior art in that they are tapered off toward the ends. Therefore, a space formed between the side faces 23*c* and 24*c* of the claw-like magnetic poles 23 and 24 is substantially rhomboid when seen from a circumferential direction. A space formed between the reinforcements 40 by which the magnets 30 are fixed to the side faces 23*c* or 24*c* of the claw-like magnetic poles 23 and 24 is narrow in width but substantially rhomboid as well. Thereby, even when the ends of the claw-like magnetic poles 23 and 24 move at the time of the rotation of the rotor 7, the magnet 30 is not applied with stress and not broken.

The reinforcement 40 is fixed to the claw-like magnetic poles 23 and 24 by an adhesive or the like. Since the reinforcement 40 is made from a metal, the inner faces 23*a* and 24*a* of the claw-like magnetic poles 23 and 24 may be welded to the inner portion 40*a* of the reinforcement 40.

Although the small space S is formed between both side faces 23*c* or 24*c* of the claw-like magnetic pole 23 or 24 and the bent portions 40*b* of the reinforcement 40, an elastic material such as rubber or resin may be placed in this small space S. The elastic material is shaped like a triangular prism, thin plate or rod in conformity with the small space S so that it can be easily inserted into the space. The same effect as described above can be obtained and the elastic material can absorb impact force and suppress the entry of foreign matter.

Embodiment 2

In the above Embodiment 1, the cross section of the reinforcement 40 is substantially M-shaped. In this Embodiment 2, as shown in FIG. 4 and FIG. 5, a reinforcement 41 having a substantially C-shaped cross section is used.

As shown in FIG. 5, the reinforcement 41 consists of a trapezoidal inner portion 41*a* extended to the inner faces of magnets 31 along the inner face 23*a* or 24*a* of the claw-like magnetic pole 23 or 24, bent portions 41*b* bent outward from both ends of the inner portion 41*a* and holding the side faces of the magnets 31, and pressing portions 41*c* projecting from the ends of the bent portions 41*b* toward the claw-like magnetic pole 23 or 24 and pressing the magnets 31 inward. The pressing portions 41*c* do not need to cover the entire outer faces of the magnets 31 and extend to intermediate positions of the outer faces of the magnets 31 to cover more than half the outer faces of the magnets 31 so that they can hold the magnets 31 firmly. There is a gap between the pressing portion 41*c* and the claw-like magnetic pole 23 or 24 so that part of the outer face of the magnet 31 is exposed.

The magnet 31 is sandwiched between the bent portion 41*b* of the reinforcement 41 and the side face 23*c* or 24*c* of the claw-like magnetic pole 23 or 24 from the inner side and fixed to the claw-like magnetic pole 23 or 24 by holding it on the outer side of the reinforcement 41.

The pressing portion 41*c* prevents the magnet 31 from falling off from the end of the claw-like magnetic pole 23 or 24 by holding the magnet 31 with the inner portion 41*a* in a wedge form because the root portion of the magnet 31 is thick.

Since three faces of the magnet 31 are almost surrounded by the reinforcement 41 and the remaining one face of the magnet 31 is in contact with the side face 23*c* or 24*c* of the claw-like magnetic pole 23 or 24, the magnet 31 has no large exposed face and has high durability. The magnet 31 can be larger in width than the magnet 30 of Embodiment 1. That is, when attention is paid to the space between the claw-like magnetic poles 23 and 24, the reinforcement 41 does not need to have a portion corresponding to the folded portion 40*d* of the reinforcement 40 and the thickness in a circumferential direction of the reinforcement 41 is smaller than that of the reinforcement 40. As a result, the magnet 31 becomes larger than the magnet 30 and the output of the car AC generator rises.

Like Embodiment 1, there is a small space S between the side faces 23 or 24 of the claw-like magnetic pole 23 or 24 and the magnets 31 and other portions are fixed by an adhesive or the like. That is, the boundary between the magnet 31 and the bent portion 41*b* and the pressing portion 41*c* of the reinforcement 41 is coated with an adhesive and these elements constitute a side magnet body 51.

When the moment of centrifugal force 31E applied to the gravity center 31*j* of the magnet 31 is taken into consideration, it is the same as in Embodiment 1. That is, the side magnet body 51 displaces in the center direction of the claw-like magnetic pole 23 or 24 with the fulcrum H of the inner portion 41*a* located at a corner portion between the side face 23*c* or 24*c* and the inner face 23*a* or 24*a* of the claw-like magnetic pole 23 or 24 as the center of movement.

The difference between Embodiment 1 and Embodiment 2 is that the length of the inner portion 41*a* covering the inner faces of the magnets 31 of the reinforcement 41 is larger than the length of the inner portion 40*a* and force for offsetting the spring-back of the reinforcement 41 is larger in Embodiment 2 because the magnets 31 are arranged on the outer side of the reinforcement 41. Thereby, the prevention of the magnets 31 from falling off is promoted and the claw-like magnetic pole 23 or 24 and the magnets 31 are connected to each other more firmly.

As shown in FIG. 6, stopping portions 41*n* and 41*n* may be formed by bending the both upper and lower ends of the inner portion 41*a* of the reinforcement 41. Thereby, the magnets 31 can be prevented from falling off from the end and root sides of the reinforcement 41 without fail. The stopping portions 41*n* may be formed at both upper and lower ends of the bent portions 41*b*.

Embodiment 3

In the above Embodiment 1, the small space S is formed between the side faces 23*c* or 24*c* of the claw-like magnetic pole 23 or 24 and the bent portions 40*b* of the reinforcement

40. In this Embodiment 3, as shown in FIGS. 7(*a*) and 7(*b*), the magnet **30** is bonded to the pressing portion **40***c* and the folded portion **40***d*. The pressing portion **40***c*, the folded portion **40***d* and the magnet **30** constitute a side magnet body **50**. A small space U is formed between adjacent side magnet bodies **50** and a small space T is formed between the bent portion **40***b* of the reinforcement **40** and the side face of the magnet **30**.

In this case, the center of the movement of the side magnet body **50** differs from those of other embodiments and the side magnet body **50** is supported at one side with the outer end of the bent portion **40***b* as a fulcrum J. The side magnet body **50** is displaced in a direction opposite to that of Embodiment 1 by the moment of centrifugal force applied to the gravity center of the magnet **30**. That is, the side magnet body **50** moves to the adjacent side magnet body **50** in a direction that the folded portions **40***d* of the adjacent reinforcements **40** are brought close to each other, that is, toward the center in a circumferential direction of the claw-like magnetic pole **23** or **24** to reduce the small space U.

The above small space S may not be formed in this case. When the space is formed, the side face **23***c* or **24***c* of the claw-like magnetic pole **23** or **24** and the bent portion **40***b* of the reinforcement **40** may be bonded together by an adhesive, or an elastic material such as a resin maybe placed in the space S and the space S may be smaller than the small space T.

As shown in FIG. 7(*b*), since the inner side of the side magnet body **50** is displaced in a circumferential direction that the small space U is reduced at the time of the rotation of the rotor **7**, the adjacent side magnet body **50** is also displaced in a direction that the small space U is reduced. Then, the folded portions **40***d* of the reinforcements **40** are contacted to each other and the adjacent side magnet bodies **50** are supported by each other. Thus, unrequired displacement is suppressed, thereby making it possible to improve resistance to centrifugal force at the time of high-speed rotation. Since the reinforcements **40** are contacted to each other, the magnets **30** are not affected. Also, the bent portions **40***b* of the reinforcements **40** on the claw-like magnetic pole **23** and **24** sides from the fulcrum J as the center of movement are not affected.

Embodiment 4

In the above Embodiment 2, the pressing portion **41***c* of the reinforcement **41** extends to an intermediate position of the outer face of the magnet **31**. In this Embodiment 4, as shown in FIG. **8** and FIGS. 9(*a*) and 9(*b*), thin contacting portions **41***t* and **41***t* extend to part of the outer face **23***b* or **24***b* of the claw-like magnetic pole **23** or **24** from both upper and lower ends of the pressing portion **41***c*. FIGS. 9(*a*) and 9(*b*) are sectional views cut on line B—B and A—A of FIG. **8**, respectively.

The contacting portions **41***t* extend to intermediate positions of chamfered portions **23***m* or **24***m* formed at both ends in a circumferential direction of the outer face **23***b* or **24***b* of the claw-like magnetic pole **23** or **24** to prevent the reinforcement **41** from falling off from the claw-like magnetic pole **23** or **24** in an inward direction.

This does not require the additional step of processing the claw-like magnetic poles **23** and **24**. However, when they are processed for a design reason, they may be processed to a thickness corresponding to the thickness of the contacting portion **41***t* and its influence upon a magnetic circuit can be ignored. Since part of the contacting portion **41***t* projects from both ends in an axial direction of the pressing portion **41***c* of the reinforcement **41**, the exposed area of the magnet **31** is secured and coolability is not reduced.

According to this constitution, when the reinforcement **41** and the magnets **31** are to be attached to the claw-like magnetic pole **23** or **24** by an adhesive, they do not need to be held with a jig, thereby making possible a great cost reduction. Also, even when the deterioration of the adhesive with the passage of time is taken into consideration, as the contacting portion **41***t* and the inner portion **41***a* of the reinforcement **41** continue to hold the claw-like magnetic pole **23** or **24** and do not lose holding power, a high-reliability and high-quality product can be obtained.

To form the contacting portions in the reinforcement **40**, parts of upper and lower ends of the pressing portion **40***c* may be folded toward the outer face **23***b* or **24***b* of the claw-like magnetic pole **23** or **24**, or a plate-like contacting piece may be bonded to the pressing portion **40***c* or **41***c*.

Embodiment 5

In the above Embodiment 4, the chamfered portions **23***m* and **24***m* of the claw-like magnetic poles **23** and **24** are not processed. In this Embodiment 5, as shown in FIG. **10** and FIGS. 11(*a*) and 11(*b*), stepped portions **23***h* and **24***h* are formed by slightly depressing portions corresponding to the contacting portions **41***t* and **41***t* of the chamfered portions **23***m* and **24***m*, respectively. The stepped portions **23***h* and **24***h* limit the movements in an axial direction of the contacting portions **41***t* and prevent the reinforcements **41** from falling off from the ends of claw-like magnetic poles **23** and **24**. FIGS. 11(*a*) and 11(*b*) are sectional views cut on line C—C and A—A of FIG. **10**, respectively.

The stepped portions **23***h* and **24***h* are formed such that the outer faces **23***b* and **24***b* of the claw-like magnetic poles **23** and **24** become almost flush with the contacting portions **41***t* and **41***t* when the reinforcements **41** are attached to the claw-like magnetic poles **23** and **24**. When the contacting portions **41***t* and **41***t* are fitted in the stepped portions **23***h* and **24***h*, the reinforcements **41**, that is, the magnets **31** are connected to the claw-like magnetic poles **23** and **24** firmly. Therefore, the entire outer surface formed after assembly is a smoothly curved surface which reduces air resistance and does not worsen rotation resistance.

The stepped portions **23***h* and **24***h* can be formed by slighting changing the shape of part of each of the chamfered portions **23***m* and **24***m* of the claw-like magnetic poles **23** and **24** and do not require separate members to be added. The stepped portions **23***h* and **24***h* may be formed with a mold for forming the pole core bodies **21** and **22** or may be formed by processing the chamfered portions **23***m* and **24***m*. The stepped portions **23***h* and **24***h* can be formed simply by slightly depressing, thereby exerting no magnetic influence upon the claw-like magnetic poles **23** and **24**.

As a result, an adhesive for fixing the reinforcement **41** and the magnets **31** to the claw-like magnetic pole **23** or **24** is not necessary, thereby further reducing costs and facilitating production.

Embodiment 6

In the above Embodiment 2, the reinforcements **41** are fixed to the claw-like magnetic poles **23** and **24** by an adhesive alone. In this Embodiment **6**, as shown in FIGS. 12(*a*), 12(*b*) and 12(*c*), a ring-form pressing member **60** for pressing the reinforcements **41** against the claw-like magnetic poles **23** and **24** from the inner side is used. This prevents the reinforcements **41** from falling off from the

inner sides or end sides of the claw-like magnetic poles **23** and **24**. Compared with Embodiments **4** and **5**, the reinforcements **41** are attached to the claw-like magnetic poles **23** and **24** more firmly.

After the reinforcements **41** holding the magnets **31** are located at predetermined positions of the claw-like magnetic poles **23** and **24** as shown in FIG. **12**(*a*), the pressing member **60** having such a diameter that it contacts the center portions of the inner portions **41***a* of the reinforcements **41** is set as shown in FIGS. **12**(*b*) and **12**(*c*). This pressing member **60** has a peripheral surface which is inclined in conformity with the inclination in an axial direction of the inner portion **41***a* of each of the reinforcements **41** and has high adhesion with a large adhesion area.

Thereby, the pressing member **60** can hold the reinforcements **41** firmly while the reinforcements **41** are attached to the claw-like magnetic poles **23** and **24**, and the AC generator can be carried without a trouble after assembly. A plurality of the reinforcements **41** can be fixed to the claw-like magnetic poles **23** and **24** at the same time and the structure of the reinforcement **41** can be made simple. The pressing member **60** are made from a metal or plastic and may have a rectangular cross section.

When an adhesive is coated to the claw-like magnetic pole **23** or **24** and the reinforcement **41**, adhesion surfaces are brought close to each other, thereby making it unnecessary to hold the reinforcements **41** and the claw-like magnetic poles **23** and **24** excessively and securing sufficient adhesion strength. When the plurality of reinforcements **41**, the magnets **31** and the pressing member **60** are held by a jig at the time of assembly and connected to the claw-like magnetic poles **23** and **24**, fixing by the adhesive is not necessary.

The pressing member **60** may be used for the reinforcements **40**. In this case, the inner portions **40***a* of the reinforcements **40** are pressed by the pressing member **60**.

Embodiment 7

In the above Embodiment **6**, the peripheral surface of the pressing member **60** contacts the inner portions **40***a* and **41***a* of the reinforcements **40** and **41**. In this Embodiment **7**, as shown in FIG. **13** and FIG. **14**, a ring-form pressing member **70** has a cylindrical peripheral surface **70***b* conformed to the peripheral surface of the rotor **7** and grooves **70***m* in which the claw-like magnetic poles **23** and **24** held in the reinforcements **40** are fitted are formed in the peripheral surface **70***b*. As shown in FIG. **14**, when the rotor **7** is assembled, the peripheral surface of the rotor **7** forms an almost completely cylindrical curved surface together with the outer faces **23***b* and **24***b* of the claw-like magnetic poles **23** and **24**.

As shown in FIG. **13**, there is a space between the inner wall of the pressing member **70** and the rotor coil **13** and cooling air **70**F passes through the space to cool the rotor **7**.

Since the reinforcements **40** are thereby pressed from the inner side to the outer side by the pressing member **70** having a large width in an axial direction, they can be connected to the claw-like magnetic poles **23** and **24** more firmly than in Embodiment **6**. Further, even when the rotor **7** has a plurality of magnets **30**, it has the effect of preventing wind sound from getting worse by rotation because it has a cylindrical curved peripheral surface **70***b*. The pressing member **70** is wide enough to cover the ends of the claw-like magnetic poles **23** and **24** but may be wide enough to extend to the end surfaces of the base portions **21***k* and **22***k* of the pole core bodies **21** and **22**.

Embodiment 8

In this Embodiment **8**, as shown in FIGS. **15**(*a*) and **15**(*b*), the inclination angles of the side faces **23***c* and **24***c* of the claw-like magnetic poles **23** and **24** are set such that the outer faces **23***b* and **24***b* of the claw-like magnetic poles **23** and **24** become wider than the inner faces **23***a* and **24***a*. The reinforcements **40** and **41** are formed in conformity with the side faces **23***c* and **24***c* which are inclined more.

Thereby, the ends on the inner sides of the magnets **30** and **31** are hardly seen from a circumferential direction and the magnets **30** and **31** are arranged as if they were hidden on the inner face **23***a* and **24***a* sides of the claw-like magnetic poles **23** and **24**.

In this case, centrifugal force **30**E or **31**E applied to the magnet **30** or **31** is divided into two segments. That is, resistance **30**K or **31**K applied to the side face **23***c* or **24***c* in a vertical direction increases and dispersion force applied to the side face **23***c* or **24***c* in a horizontal direction decreases. Therefore, the centrifugal force resistance of the side magnet body **50** or **51** is improved.

Embodiment 9

In this Embodiment **9**, as shown in FIG. **16**, the root portion **30***n* or **31***n* of the magnet **30** or **31** is made thicker than the end portion **30***s* or **31***s* when seen from the cross section in a circumferential direction of the claw-like magnetic pole **23** or **24**. In the figure, the reinforcements **40** and **41** are omitted and the shapes of the magnets **30** and **31** are shown when seen from the cross section in a circumferential direction of the claw-like magnetic pole **23** or **24**.

That is, the gravity center of the magnet **30** or **31** is located closer to the root side rather than the end side of the claw-like magnetic pole **23** or **24**, that is, to the base portion **21***k* or **22***k* of the pole core body **21** or **22**. Thereby, the displacement of the end portion of the claw-like magnetic pole **23** or **23** which is moved by magnetic attraction force or centrifugal force generated by the rotation of the rotor **7** can be reduced. That is, force influencing the magnet **30** or **31** can be reduced.

As having been described above, according to the first aspect of the present invention, the rotor structure comprises a rotor coil for generating a magnetic flux, a pole core which covers the rotor coil and consists of a first pole core body and a second pole core body, each having a plurality of claw-like magnetic poles which are mated with each other, magnets provided on both sides of each claw-like magnetic pole to suppress the leakage of a magnetic flux between the side faces of adjacent claw-like magnetic poles, and reinforcements for holding the magnets in such a manner that the magnets are inclined so that the interval between the magnets becomes larger on the outer side than on the inner side. Therefore, the magnets can be fixed to each claw-like magnetic pole without fail while they are surrounded by the reinforcement, the strength of a side magnet body composed of the magnet and portions holding the magnet of the reinforcement can be enhanced without taking some measure for the magnets, and the centrifugal force resistance thereof is high.

According to the second aspect of the present invention, the reinforcement consists of an inner portion conformed to the inner face of the claw-like magnetic pole, bent portions bent from both ends of the inner portion toward the side faces of the claw-like magnetic pole, pressing portions, bent from the bent portions, for pressing the outer faces of the magnets, and folded portions folded from the pressing portions toward the side faces of the magnets, and the magnets are held on the inner side of the reinforcement. Therefore, as the reinforcement is easily manufactured at a low cost, has high strength and is formed continuous on the

inner face and the side faces of the claw-like magnetic pole, it can receive centrifugal force and moving force applied to the claw-like magnetic pole with the entire surface from the inner side and can reduce force affecting the magnets.

According to the third aspect of the present invention, the reinforcement consists of an inner portion conformed to the inner face of the claw-like magnetic pole and the inner faces of the magnets, bent portions bent from both ends of the inner portion toward the side faces of the magnets, and pressing portions, projecting from the bent portions toward the claw-like magnetic pole, for pressing the outer faces of the magnets, and the magnets are held on the outer side of the reinforcement. Therefore, as the reinforcement can be easily manufactured at a low cost and is formed continuous on the inner face of the claw-like magnetic pole and the inner faces of the magnets, it can receive centrifugal force and moving force applied to the claw-like magnetic pole with the entire surface from the inner side and can reduce force affecting the magnets.

According to the fourth aspect of the present invention, since the magnet and portions holding the magnet of the reinforcement constitute a side magnet body, a space is formed between the side magnet body and the side face of the claw-like magnetic pole, the side magnet body moves toward the claw-like magnetic pole to reduce the space when centrifugal force is applied to the magnet, and the reinforcement is deformed by this moving force to absorb the centrifugal force. Therefore, even when centrifugal force is generated by the rotation of the rotor, the side magnet body moves and displaces toward the center direction of the claw-like magnetic pole so that it holds the claw-like magnetic pole, whereby the holding power of the reinforcement is strengthened and the centrifugal force resistance thereof is high.

According to the fifth aspect of the present invention, the center of the movement of the side magnet body is located on the claw-like magnetic pole side of the line connecting the center of the rotation axis of the rotor and the gravity center of the magnet, and the movement of the side magnet body is stopped when it contacts the side face of the claw-like magnetic pole. Therefore, even if centrifugal force increases, the side magnet body is firmly fixed, further displacement can be suppressed, centrifugal force is not applied to the magnet, and the centrifugal force resistance of the side magnetic body is high.

According to the sixth aspect of the present invention, the magnet is held by the pressing portion and the folded portion and constitutes a side magnet body together with the pressing portion and the folded portion, a space is formed between the side magnet body and the side face of the claw-like magnetic pole, a space is formed between adjacent side magnet bodies, the side magnet body moves toward the adjacent side magnetic body to reduce the space between the adjacent side magnet bodies when centrifugal force is applied to the magnet, the reinforcement is deformed by this moving force to absorb the centrifugal force, and the movement of the side magnet body is stopped when the adjacent folded portions contact each other. Therefore, even when centrifugal force increases, the side magnet body is firmly fixed, further displacement can be suppressed, centrifugal force is not applied to the magnet, and the centrifugal force resistance of the side magnet body is high.

According to the seventh aspect of the present invention, the space between the side magnet body and the side face of the claw-like magnetic pole is set such that the deformed reinforcement can restore its original shape when centrifugal force is not applied to the magnet after the movement of the side magnet body is stopped and the deformation amount of the reinforcement becomes maximum. When centrifugal force is applied again, the side magnet body can move and the reinforcement can move repeatedly without being broken.

According to the eighth aspect of the present invention, the space between the side magnet body and the side face of the claw-like magnetic pole is set such that stress applied to the reinforcement falls below at least an allowable level when the movement of the side magnet body is stopped and the deformation amount of the reinforcement becomes maximum. Even when the side magnet body moves and displaces maximum, the deformation amount of the reinforcement falls below the allowable level and the reinforcement is not broken by excessive stress.

According to the ninth aspect of the present invention, since an elastic material is placed in the space between the side magnet body and the side face of the claw-like magnetic pole, foreign matter is not contained in the space or impact force to the claw-like magnetic pole can be alleviated at the time of the displacement of the side magnet body.

According to the tenth aspect of the present invention, since the rotor structure has a stopping structure for preventing the reinforcement from falling off from the claw-like magnetic pole in an inward direction, the reinforcement is connected to the claw-like magnetic pole more firmly, the magnet is not scattered and not damaged, and the reinforcement does not fall off in an inward direction even when the pole core body fitted with the reinforcements is placed horizontally in an axial direction. Therefore, the rotor structure has excellent work efficiency that it can be freely carried and set.

According to the eleventh aspect of the present invention, since the rotor structure has a stopping structure for preventing the reinforcement from falling off from the claw-like magnetic pole in an outward direction, the reinforcement is connected to the claw-like magnetic pole more firmly, the magnet is not scattered and not damaged, the reinforcement does not fall off from the claw-like magnetic pole in an axial direction, and the pole core bodies fitted with the reinforcements can be easily mated with each other with the rotor coil contained therein.

According to the twelfth aspect of the present invention, since the rotor structure has a stopping structure for preventing the reinforcement from falling off from the claw-like magnetic pole in inward and outward directions, the movement of the reinforcement in an inward direction and axial direction with respect to the claw-like magnetic pole can be limited with a simple structure without fail and the holding function of the structure is high.

According to the thirteenth aspect of the present invention, since the above stopping structure is contacting portions which project from the reinforcement and contact the outer face of the claw-like magnetic pole, they have the effect of holding the chamfered portions of the claw-like magnetic pole and preventing the reinforcement from falling off from the claw-like magnetic pole in an inward direction with a simple structure.

According to the fourteenth aspect of the present invention, since a pressing member for pressing the reinforcements against the claw-like magnetic poles from the inner side is used as the stopping structure, the movement of the reinforcements in an inward direction, axially inward direction and axial direction with respect to the claw-like magnetic poles is limited, and pressing force can be applied

to the reinforcements so that the reinforcements are pressed against the claw-like magnetic poles from the inner side.

According to the fifteenth aspect of the present invention, the above pressing member has a cylindrical peripheral surface, grooves in which the claw-like magnetic poles held in the reinforcements are fitted in are formed in the peripheral surface, and the outer faces of the claw-like magnetic poles and the peripheral surface of the pressing member form the cylindrical curved peripheral surface of the rotor. Therefore, the movement of the reinforcements in an inward direction, axially inward direction and axial direction with respect to the claw-like magnetic poles is limited with more certainty, and the entire peripheral surface of the rotor becomes a smoothly curved surface, thereby reducing wind sound generated at the time of the rotation of the rotor.

According to the sixteenth aspect of the present invention, since the side faces of the claw-like magnetic pole are inclined such that the interval between them becomes larger on the outer side than on the inner side, resistance applied to the side faces of the claw-like magnetic pole vertically increases and centrifugal force applied to the magnet alone decreases, thereby increasing the centrifugal force resistance of the side magnet body.

According to the seventeenth aspect of the present invention, since the gravity center of the magnet is located close to the root side of the claw-like magnetic pole, even when the end of the claw-like magnetic pole moves at the time of the rotation of the rotor, the amount of this movement can be reduced.

According to the eighteenth aspect of the present invention, since the reinforcement is made from a metal, it has a high degree of machining freedom and can be manufactured at a low cost.

According to the nineteenth aspect of the present invention, since the reinforcement is welded to the claw-like magnetic pole, it can be firmly connected to the claw-like magnetic pole.

According to the twentieth aspect of the present invention, since the reinforcement has a stopping structure for preventing the magnets from falling off toward the end side or root side of the reinforcement, the magnets can be prevented from falling off from the reinforcement.

What is claimed is:

1. A rotor structure comprising:

a rotor coil for generating a magnetic flux;

a pole core which covers the rotor coil and consists of a first pole core body and a second pole core body, each having a plurality of claw-like magnetic poles which are mated with each other;

magnets provided on both sides of each claw-like magnetic pole to suppress the leakage of a magnetic flux between the side faces of adjacent claw-like magnetic poles; and

reinforcements for holding the magnets in such a manner that the magnets are inclined so that the interval between the magnets becomes larger on the outer side than on the inner side.

2. The rotor structure of claim 1, wherein each of the reinforcements consists of an inner portion conformed to the inner face of the claw-like magnetic pole, bent portions bent from both ends of the inner portion toward the side faces of the claw-like magnetic pole, pressing portions, bent from the bent portions, for pressing the outer faces of the magnets, and folded portions folded from the pressing portions toward the side faces of the magnets, and the magnets are held on the inner side of the reinforcement.

3. The rotor structure of claim 2, wherein the magnet and portions holding the magnet of each of the reinforcements constitute a side magnet body, a space is formed between the side magnet body and the side face of the claw-like magnetic pole, the side magnet body moves toward the claw-like magnetic pole to reduce the space when centrifugal force is applied to the magnet, and each of the reinforcements is deformed by this moving force to absorb the centrifugal force.

4. The rotor structure of claim 3, wherein the center of the movement of the side magnet body is located on the claw-like magnetic pole side of a line connecting the center of the rotation axis of the rotor and the gravity center of the magnet, and the movement of the side magnet body is stopped when it contacts the side face of the claw-like magnetic pole.

5. The rotor structure of claim 3, wherein the space between the side magnet body and the side face of the claw-like magnetic pole is set such that each of the deformed reinforcements can restore its original shape when centrifugal force is not applied to the magnet after the movement of the side magnet body is stopped and the deformation amount of the reinforcement becomes maximum.

6. The rotor structure of claim 3, wherein the space between the side magnet body and the side face of the claw-like magnetic pole is set such that stress applied to each of the reinforcements falls below at least an allowable level when the movement of the side magnet body is stopped and the deformation amount of each of the reinforcements becomes maximum.

7. The rotor structure of claim 3, wherein an elastic material is placed in the space between the side magnet body and the side face of the claw-like magnetic pole.

8. The rotor structure of claim 2, wherein the magnet is held by the pressing portion and the folded portion and constitutes a side magnet body together with the pressing portion and the folded portion, a space is formed between the side magnet body and the side face of the claw-like magnetic pole, a space is formed between adjacent side magnet bodies, the side magnet body moves toward the adjacent side magnetic body to reduce the space between the adjacent side magnet bodies when centrifugal force is applied to the magnet each of, the reinforcements is deformed by this moving force to absorb the centrifugal force, and the movement of the side magnet body is stopped when the adjacent folded portions contact each other.

9. The rotor structure of claim 1 which has a stopping structure for preventing each of the reinforcements from falling off from the claw-like magnetic pole in an inward direction.

10. The rotor structure of claim 9, wherein the stopping structure has contacting portions which project from each of the reinforcements and contact the outer face of the claw-like magnetic pole.

11. The rotor structure of claim 9, wherein a pressing member for pressing the reinforcements against the claw-like magnetic poles from the inner side is used as the stopping structure.

12. The rotor structure of claim 11, wherein the pressing member has a cylindrical peripheral surface, grooves in which the claw-like magnetic poles held in the reinforcements are fitted are formed in the peripheral surface, the outer faces of the claw-like magnetic poles and the peripheral surface of the pressing member form the cylindrical curved peripheral surface of the rotor.

13. The rotor structure of claim 1 which has a stopping structure for preventing each of the reinforcements from falling off from the claw-like magnetic pole in an outward direction.

14. The rotor structure of claim 1 which has a stopping structure for preventing each of the reinforcements from falling off from the claw-like magnetic pole in inward and outward directions.

15. The rotor structure of claim 1, wherein the side faces of the claw-like magnetic pole are inclined such that the interval between them becomes larger on the outer side than on the inner side.

16. The rotor structure of claim 1, wherein the center of gravity of the magnet is located close to the root side of the claw-like magnetic pole.

17. The rotor structure of claim 1, wherein each of the reinforcements is made from a metal.

18. The rotor structure of claim 17, wherein each of the reinforcements is welded to the claw-like magnetic pole.

19. The rotor structure of claim 1, wherein each of the reinforcements consists of an inner portion conformed to the inner face of the claw-like magnetic pole and the inner faces of the magnets, bent portions bent from both ends of the inner portion toward the side faces of the magnets, and pressing portions, projecting from the bent portions toward the claw-like magnetic pole, for pressing the outer faces of the magnets, and the magnets are held on the outer side of the reinforcement.

20. The rotor structure of claim 1, wherein each of the reinforcements has a stopping structure for preventing the magnets from falling off toward the end side or root side of the reinforcement.

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